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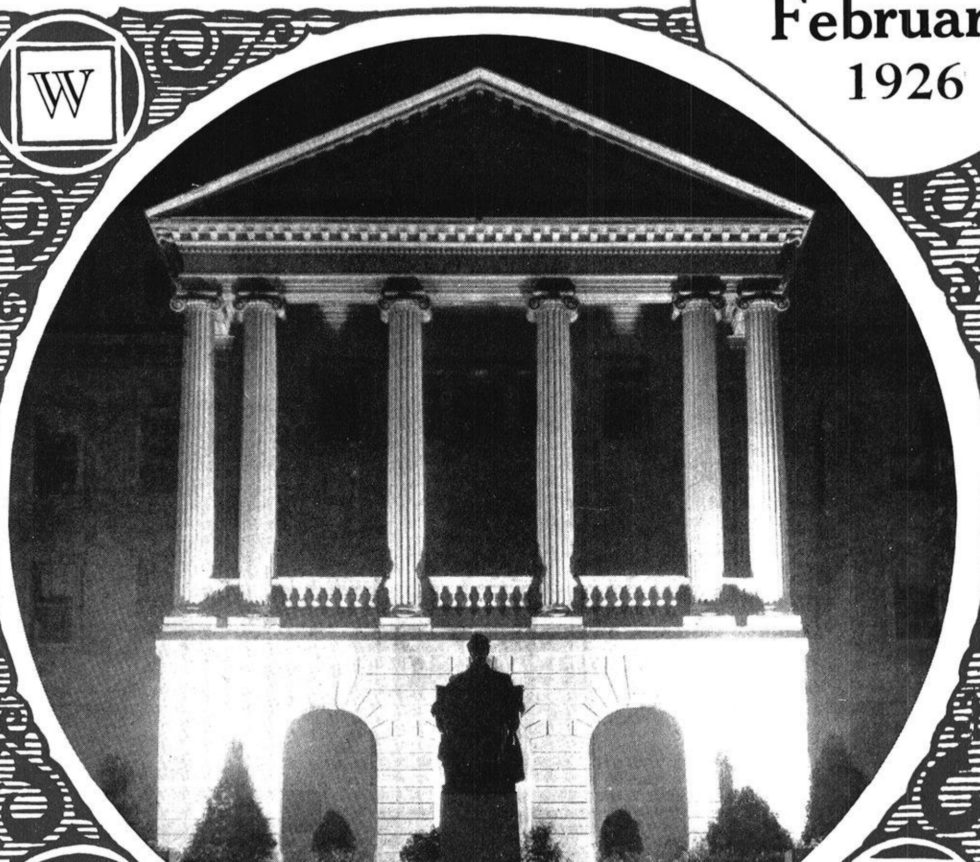

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TESTS ON CONCRETE COLUMNS REINFORCED WITH STEEL SPLICED IN VARIOUS WAYS

Reported by C. A. WIEPKING, c'21
Instructor in Mechanics

THE above is the title of a thesis submitted at the University of Wisconsin in 1924 by Mathew Turkovich for the degree of Master of Science in Civil Engineering. Since the subject matter and results of this investigation are of practical importance in design of reinforced concrete structures, the conclusions derived in this thesis are here made more available to the engineering profession.

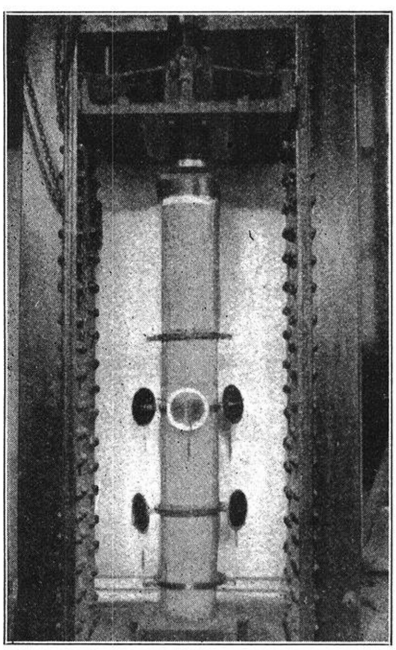


FIG. 1. *A test column ready to be loaded.*

This investigation of the effects of splicing steel in concrete compression members was undertaken because building codes of important American cities differ widely or are rather indefinite in their specifications covering this phase of design. Also, the published information on tests of reinforced concrete columns apparently did not include any report of this kind.

Laboratory Procedure

The concrete members tested in this thesis were made in September 1923 at the Laboratory for Testing Materials. After a curing period of 77 to 94 days in the moist closet, the columns were submitted to compression tests in which increasing load and deformation readings were taken. The deformations were measured by means of wire-wound dials in sets of three for each gage length, as shown in Figure 1. Changes in length were measured for the spliced portion of each column and for an unspliced portion near one end. Thus data was obtained for determining the efficiency of the splice in terms of the strength and stiffness of the unspliced portion of the column. Comparison was also made with columns having through rods (no splices) and with columns having only lateral reinforcement.

Scope of the Tests

A total of thirty-six columns, as listed in Table 1, was tested. Each column had a nominal outer diameter of eight inches and was 61 inches high. It was reinforced against lateral failure by means of a number 7 high carbon steel spiral with 1 inch pitch. The diameter of the wire forming the loops of the spiral was 0.185 inch. Using this type of hoop-reinforcement, the diameter of the cylindrical portion of concrete within the loops was about 7.63 inches.

The longitudinal reinforcement in these specimens consisted of ½-inch or ¾-inch round rods of structural steel. Six of these rods, spaced equally around the circle, were placed in each column. They were held in position by wiring them near the ends to the inside of the spiral reinforcement, using Curry bag-tie wires. The usual arrangement of reinforcement is shown in Figure 2. Fourteen of the columns were made with ½-inch rods; twenty of them had ¾-inch rods, and two were made with spiral reinforcement only. The purpose in using two sizes of rods for longitudinal reinforcement was to determine whether the efficiency of the splice varied notably with this dimension. These sizes were chosen because they are commonly used in practice.

In the case of each size of rod, several methods of splicing were selected for investigation. A third of the columns were made with butt joints, in which the rods were held in contact endwise by placing them within iron pipes used as sleeves. It was intended thus to determine whether butt-end conditions could be made as effective as solid or un-spliced rods.

Butt Splices

The ends of the rods in the butt-splices were sawed off square in two of the columns reinforced with ½-inch rods and in two reinforced with ¾-inch rods. These rods were placed into snug-fitting pipes, to insure a very close approximation to the un-spliced rod condition. A similar set was sheared off, and the wedge-shaped ends were placed together in snug-fitting pipes. The third set of butt joints was made with sheared rods placed in loosely-fitting pipe sleeves. In each case the pipes were eight inches long and extended equal distances on the two rods of the splice. The six similarly spliced rods of each column were tied into position as described above (see figure 2). Where necessary, extra ties were used to hold the pipe sleeves in place and to preserve vertical alignment. These operations were not performed with the idea of securing *perfect* splices, but rather to represent field conditions. After test it was found in some cases that rods or sleeves had slipped out of place. The amount of displacement was not great enough, in any case, to weaken the column.

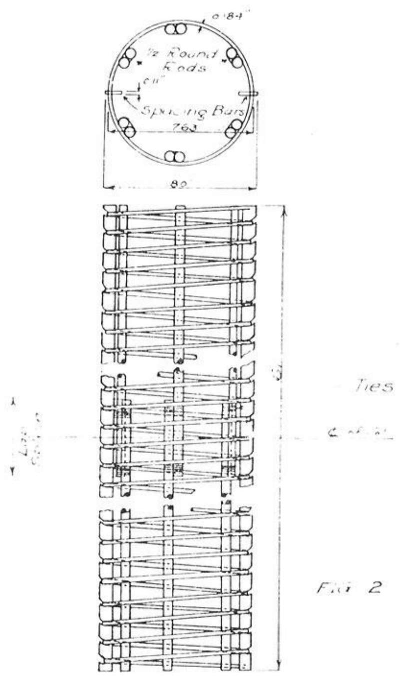


FIG. 2. *Typical arrangement of longitudinal and hoop reinforcement in a lap-spliced*

Lap Splices

The remaining columns were made with lapped splices instead of butt-ended splices. A set of twelve columns had spliced rods wired together, with laps of 2 inches, 20 diameters, and 40 diameters. This series again included ½-inch and ¾-inch rods, two specimens of each kind.

Each pair of rods was spliced by wrapping near each end with two or three turns of bag-tie wire twisted tight. In placing the sets or rods in the spirals, additional ties onto the loops were required to preserve spacing and alignment. Such splices and ties were not expected to materially affect the vertical load capacity of the rods, except by friction between the rods. It was thought that the strength of the joint would depend mainly on the bond stresses between steel and concrete and on the endwise bearing of the sheared ends on the concrete mass.

The six remaining lap-spliced columns were all made with ¾-inch rods. In these the 2-inch, 20-diameter, and 40-diameter laps were again used, but the pairs of rods were not wired together. They were tied into position inside the spirals so that the upper and lower rods of each pair were approximately parallel but about 1 inch apart circumferentially. This method of splicing was investigated to determine whether friction between tied rods would be an appreciable factor toward increasing splice efficiency.

Bearing of Rods at Column Ends

In all of these splices the attempt was made to have the rods flush with the bearing surface of the concrete both top and bottom; also, the ends of the spliced bars at top and bottom of the columns were sawed square regardless of the splice condition. The aim was to have each rod or spliced pair of rods receive an equal portion of the load. By such procedure the theoretical ratio between stress in steel and stress in concrete was to be closely approximated, at least in the more efficient splices. Considerable difficulty was encountered in making the spliced pairs exactly 61 inches in length, even in the case of the rods with ends sawed. This was due to inaccuracy of the saw cut, as several rods were clamped in the power saw at a time. When sheared ends or lapped splices were used, the irregularity was considerably greater. Such discrepancies would be even more common in the field, but would be offset by the fact that loads are not applied to a plane end surface of a column in the ordinary concrete structure.

Method of Loading

In testing these columns, the 600,000-lb. vertical testing machine was used. Usual precautions were taken in centering and plumbing each column, in providing a smooth plaster-of-paris cap and in using a spherical head for applying loads. The increments of load were 20,000 or 30,000 lb.; the rate of application was such that the ultimate load (about 300,000 lb.)

FIG. 3. *Butt and lap splices after testing.*

was reached in about half an hour. This allowed time for reading deformation dials after each increase of load.

Four of the columns were further investigated for the time effect of constant load. For this purpose columns with ¾-inch rods were selected; one had a lap joint of 40-diameters with rods wired together; the others were lap joints of 2 inches, 20-diameters, and 40-diameters, with rods not wired together. In each case the usual observations were taken until a 200,000 lb. load had been applied. This load was then maintained on the column for four hours, and deformation dial readings were taken every hour. Upon securing this data indicating effect of time upon increment of deformation, the load was increased until failure resulted.

Deformation Readings

As mentioned earlier, the deformation readings consisted of two sets. One was for a gage length of 10.3 inches, including the splice. The other gage length was near the end of the column where splice conditions did not exist. In the case of the butt-joints the splice deformations were read in the middle of the column, thus indicating the effect of the displacement or compression of butt ends. This was also the case for columns in which the rods were lapped 2 inches, and for one of each of the other lap-spliced specimens. The remaining specimens were set up so that the splice deformation was measured over the ends of the rods. This scheme was followed to show whether strain in the splice portion existed at the ends of rods only, or whether uniformly throughout the splice portion. It was also intended to show the stiffening effect, if any, of the double rod within the splice portion of the column.

Curves and Computations

For each column, load-deformation curves were drawn, showing the changes in the splice and outer gage lengths. The unit loads were computed by dividing the successive total column loads by the total cross sectional area of the column. This method was employed until a load value was reached at which the outer part of the column had exhibited scaling or chipping of the concrete. For higher loads the unit values were based on the area inclosed within the spiral reinforcement only, because the outer layer of concrete was no longer effective.

The unit deformations for each gage length were determined by averaging the increments of readings of the three dials and dividing by 10. The gage length used was 10.3 inches in each case, the extra 0.3 inch allowing for the thickness of the compressometer wires.

These curves indicated that the splice and outer gage lengths deformed by practically equal amounts and in direct proportion to the load increments until the average stress was about 2000 lb. per sq. in. For higher values the curves for the two gage lengths deviated, the splice gage usually showing the greater deformation.

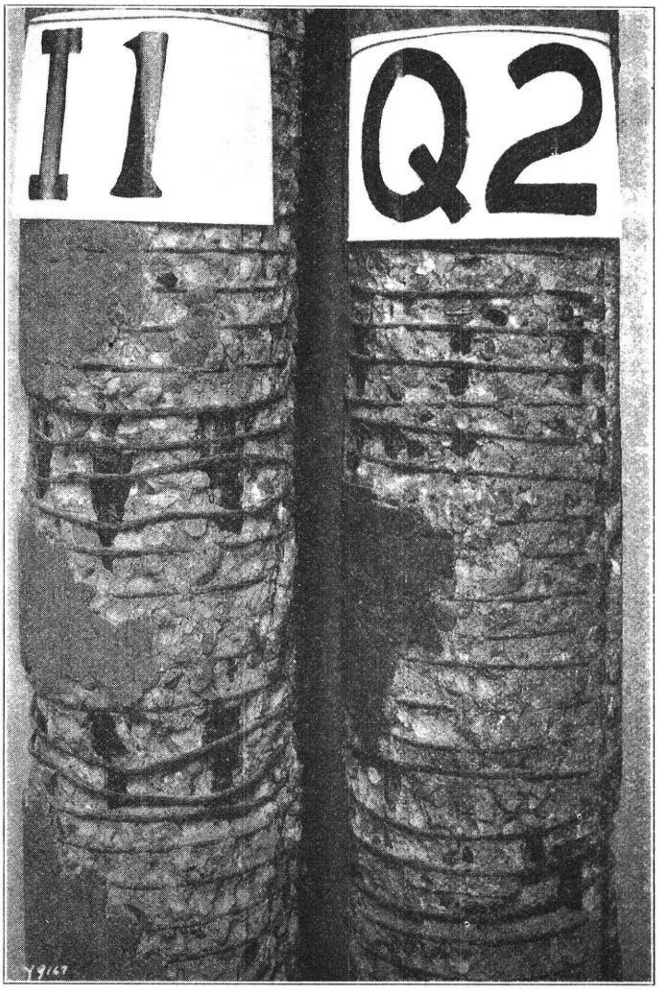


FIG. 4. *Tested columns with splice rods exposed.*

However, the splice gage lengths exhibited less deformation than the outer gage lengths in the columns in which rods were lapped 20 and 40 diameters.

Strength of Splices

Table I is a summary showing the sizes of reinforcing rods, methods of splicing, and unit strengths of the columns. For comparative purposes the average compressive strength of auxiliary 6 x 12-inch cylinders representing the concrete in each column is also given (division 6). The ultimate unit loads (P/A) were computed by dividing the highest column load by the net or core area of each. The values for each pair of similar columns were averaged, and the relative strengths in the last division were computed from the averages. For this strength comparison the columns in each series having no splice were used as bases.

It will be noted that all the columns of the first set, which had ½-inch reinforcing rods, developed very nearly the same strength. The pair of columns with 2-inch lap splices were the only ones showing less strength than the solid column. Evidently the bond of concrete on steel in the longer lapped splices was sufficient to develop the full strength, because the surface area of ½-inch rods is relatively high.

(Continued on page 158)

RAISING THE SOUTHERN CROSS

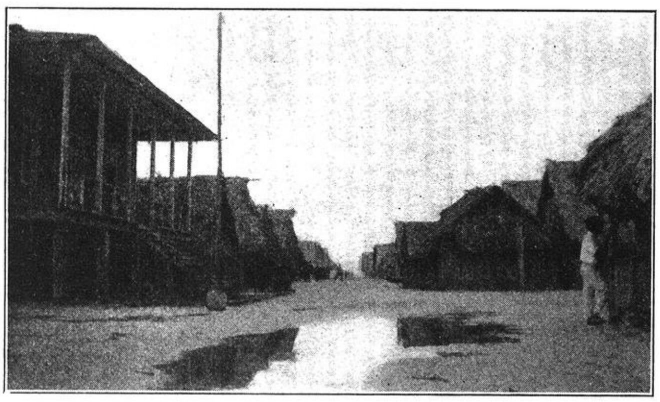
A STORY OF RAILROADS AND REVOLUTIONS

By WILLIAM J. FIELDING

THE International Railways of Central America are at the present time completing a connecting link between the City of San Salvador and Guatemala City, to be known as the Soyapango and Texistepeque Railway. This cut-off will be a trans-continental as well as an international railroad, and when completed, will boast of sixty miles of track, two twenty-five-ton wood-burning locomotives and a dozen cars, in addition to numerous tin-roofed stations and water tanks.

The gauge is one meter, rail weight forty-five, ties of tropical cedar and mahogany, and track ballast of volcano ash. Limit of curvature is twenty degrees, and maximum grade is three per cent.

The writer spent several months with the engineering crew on this project, and lived in camp in the jungle



The principal avenue of Santa Isabel.

along the proposed right-of-way. It was rough and tough, and somewhat of a gamble, this life in the remoteness of interior Central America; but this is the kind of job that brings together some highly interesting fellows, and the hardships were tempered by good company.

Tidings of a construction project find their way from coast to coast across the sierras, and filter through to the Gringo's favorite cantinos and clubs; from the Rio Grande to the Amazon, the siren calls to the itinerant tropical engineer to commence a new crusade. And so with Soyapango and Texistepeque. She did not wait long after getting her S. O. S. on the air, for the veterans of Panama, of Quito and the Chauganola, the Mamore and Madeira were standing by, and the pilgrimage to El Salvador was on. They drifted in, engineers, bridge-men, clerks, and general construction-men, and the long siesta of the Salvadorian along the Cannes River was at an end.

Among the recruits were General Jeffries and Col. Jock Eveline. Jock Eveline had come over the border from Honduras with five hundred men — soldiers of late, but now pick-shovel and pan-car men. The general came in on his mule, unattended.

There's a long story connected with the arrival of these two worthy recruits, several stories in fact. The following is an outline of the most popular version:

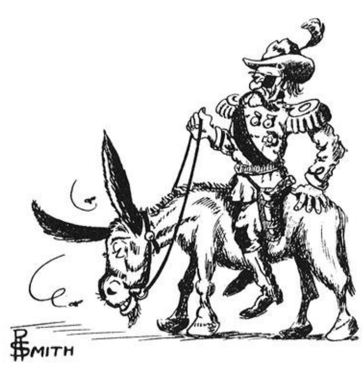
It happened during the revolution before last, so no diplomatic secrets are being divulged here.

About the time the Soyapango Railway construction broke out and disturbed the beautiful occupation of revolution and counter-revolution, General Jeffries was engaged by a Viva La Libertad party in Honduras as division engineer in charge of ousting the government forces under Jock Eveline in Santa Isabel, a stronghold in the interior. Colonel Jock Eveline, occasional engineer, gun-runner, and what have you, due to his military position was certainly, for the time, a big man in Santa Isabel.

On his arrival into Jock's territory, Jeffries dispatched a nasty note to the colonel. "Be your age, Jock. I've got a machine gun, a good gang of mozos and plenty of cartridges. You're a big boy now, so behave yourself. Come out and hook up with the victorious party. There's good money in it for you."

Jock answered this message in what might be considered a frivolous tone, in view of the gravity of the situation.

"Same to you, General, and many of them. If you'd paid me the ten-spot you borrowed last June down in Limon when I pulled you off the beach, I might consider the proposition. I don't think this government likes her job. I believe she's going to resign soon anyway. But I know what kind of whack-up you'd make with me. I've got two machine guns. Adios!

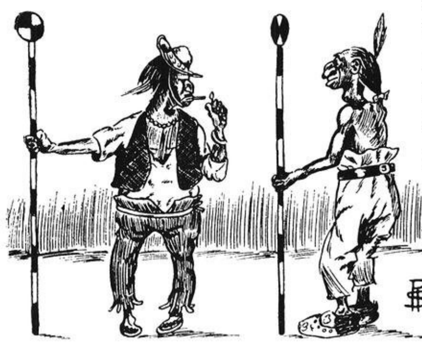


"The General came in on a mule, unattended --"

"P. S. I hear they need railroad men in Salvador. Entiende?"

So the general opened up on Jock's adobe coffee store-house, and kept up the tatoo until the gun jammed, and then noticed that the government forces were not playing fair. They hadn't returned a shot. The general pondered heavily on this unusual situation. "What would Napoleon do in a case like this? I have it! The coffee-house! La Casa de Cafe, hombres! Viva el Dinero!" And Santa Isabel fell.

Santa Isabel falls twice a year, so the populace is accustomed to it. It was "Viva General Jeffries, Americano Grande!" that greeted the revolutionary gang as they entered the town, and not resistance. No soldiers; no Colonel Eveline to surrender his safety razor to the hero of the people. A few mozos and their women came out of their shacks to viva the general. The doors of the cantina swung open to reveal the form of a typical tropical tourist, originally from Clarksburg, West Virginia; but just now from the Golden realms of Bacchus. "Whatthehell's the racket? Who started this fourth of July celebration on my birthday? Oh, it's Jeffries! Come in and have one on you. Haven't seen seen you since we had the run-in with the vigiliants at Bocas. Got that five on you? Were you inquiring for Jock Eveline? I heard you knocking some one a while ago. Jock's hit the breeze. We were rebuilding the Panama Canal in here when you interrupted. Jock's resigned, and General Don Hoothelisit has has taken Jock's outfit to back up the garrison at the capital. If this shooting eeps up, I'm going o see the consul, and try to have a marine stationed in this town. My American interests are going to be protected against you Gringos. Why, a man would be safer back home. General, you haven't treated our Santa Lizzie right."



"We hired Indians and made them into rodmen and chainmen."

But Jock Eveline hadn't gone far. That night he got in touch with Jeffries' lieutenants, and by judicious expenditures, and rosy promises, he organized a crack construction force, and while the general dreamed of looted treasuries, his army had started along the trail for Salvador, where rice and frijoles were a certainty, with a peso or two for the Sunday cock-fight.

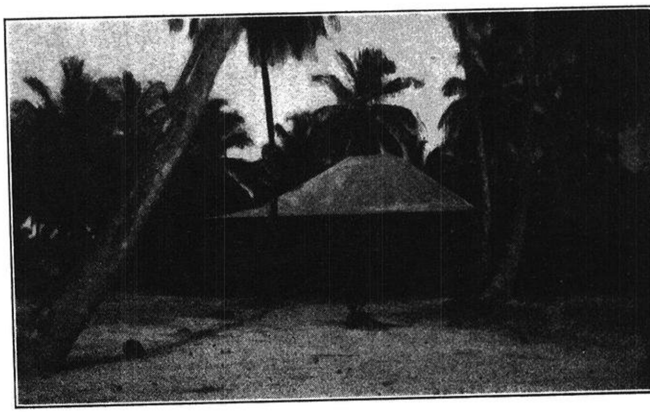
This left Jeffries armyless, and assuredly very much in bad with the revolutionary leaders. It was certainly his move. So he, too, took the only trail open,—that trail leading over the border to Salvador and the Soyapango, and brought up at Finca Prusia where Colonel Jock had already established his contractors' camp, and had the flower of Jeffries' patriotic army corps swinging the pick on the grade.

"So you took my tip about the railroad work here, general. I knew you'd like the proposition. You're hired as super on my contract, and you've got your army back."

And Jock Eveline has added another chapter to his life-story, by stealing an army, and getting away with it. General Jeffries is temporarily out of politics, and instead of leading successful revolutions, and forlorn hopes, is pushing the rail-head of the Soyapango in a masterful manner over another but safer frontier.

The Santa Isabel muddle is not by any means the cue for either Jeffries or Eveline to respond with the swan song. True disciples of Lee Christian, they'll act as campaign managers for many a Central American presidential election yet.

And there was G. M. Thompson, clerk at headquarters. He heard about the job when down on the beach at La Union. For several weeks he had been on a diet of bananas and shell fish. His meals were rather irregular as the table couldn't be set until the tide went out. He sold out his fishing interests at La Union, and trailed into camp, weary, hungry, and foot-sore — pretty well down, but far from out. He packed a smile, an excellent line, and a general appearance that landed him the job he came after.



"Residences were established at ten-mile intervals."

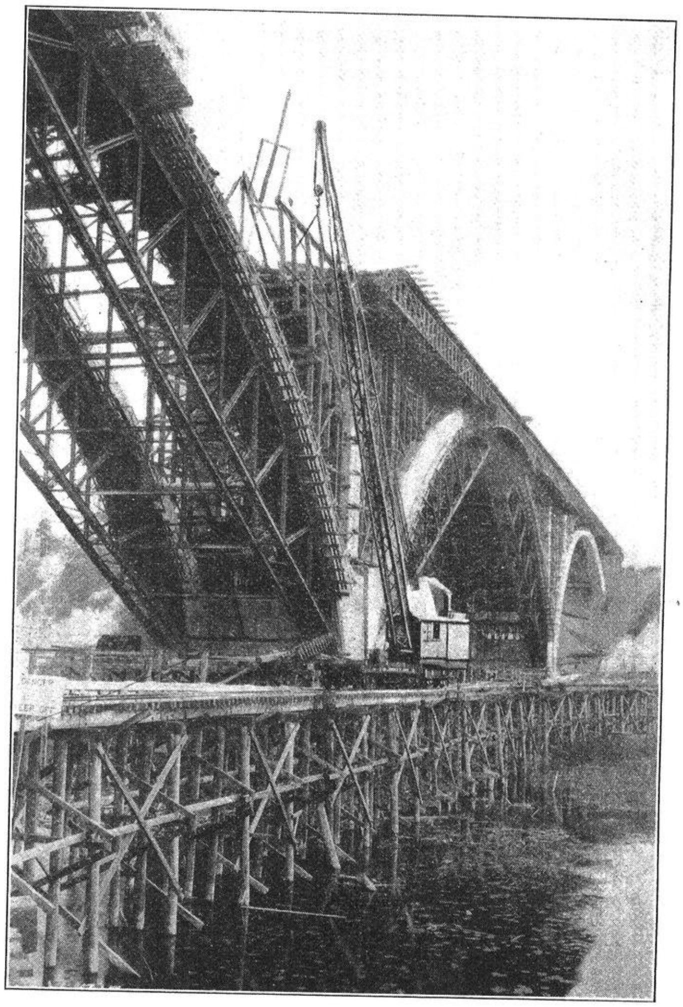
Residences were later established at ten-mile intervals, and resident engineers were sent out along the line to establish their camps and get the work going. We had no technical assistants or transitmen. We had to fight it out alone· We hired as many Indians as we could conveniently use at fifty-cents gold per day, and proceeded to make them into rodmen and chainmen. They did very well, and, considering the fact that contractors were on the job with their equipment and crews before a preliminary hub was driven, we pulled out of the mix-up wonderfully well.

A day's schedule was about as follows: Breakfast at five, in the saddle before six, and in the field until four. Then return to camp, work out a location from our preliminary, or figure yardage from our slope-staking notes. The section I worked on paralleled the Cannes River canyon. The line traversed a jumbled mess of scrambled topography, the after effect of a recent eruption, and it required skill and hard work to hit on a good location. Eventually, we solved our location dilemma by approximating a parallel with the general slope of the sierra, and letting Nature take her course. We put in some fearful curves, and erratic grades. The tourist of next year is going to have an exceptionally interesting railroad ride.

We were not so far into the jungle at the start of the job, and on Saturdays would head for the city of San

(Continued on page 176)

THE LONGEST CONCRETE ARCH-BRIDGE IN THE WORLD



Construction work on the forms.

The Ft. Snelling-Mendota bridge is a concrete arch-bridge, nearly a mile in length, requiring two and one-half years for construction, and costing about $1,700,000.

ONE of the largest and most interesting improvements now under way in the country is the Ft. Snelling-Mendota bridge spanning the Minnesota River Valley and connecting the Twin Cities with the town of Mendota and the Jefferson Highway on the south.

The north approach of the bridge runs through the Fort Snelling reservation which was purchased from the Indians in 1805 by Zebulon M. Pike for $200 worth of assorted beads, hatchets, calico, etc., and 60 gallons of "firewater." Liquor today is much scarcer and more expensive than it was in those days, but one would need an awful lot of it to buy nine square miles of territory touching on both of the Twin Cities — Minneapolis and Saint Paul.

In February 1819 the 5th U. S. Infantry was ordered to the Fort, and found the Minnesota winter so inhospitable that half of the soldiers died the first year. The fort was first called Fort St. Anthony, but the name was changed later to honor Colonel Snelling, who took command in 1820.

Mendota, at the southern terminus of the bridge, is the oldest town in Minnesota. It stands at the point where the Minnesota River runs into the Mississippi and its name is a Sioux word meaning "mouth of the river." About 1790 the French established a trading post at this point which they called St. Pierre.

In 1826 Jean Baptiste Fairbault, for whom a county in Minnesota is named, built a log house at Mendota, and in 1834 General Sibley made Mendota the headquarters of the American Fur Co., which did a yearly trade of around $300,000 in skins. The Sibley House is still standing at Mendota.

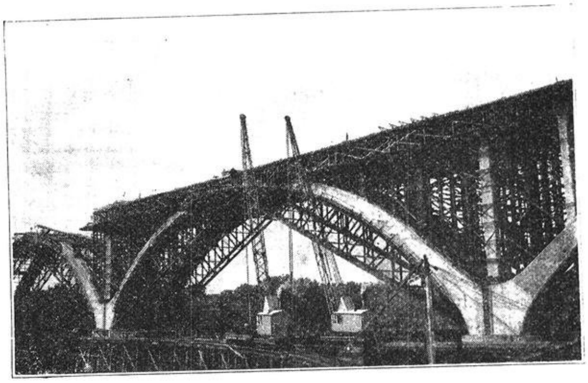
For the last eighty years or so a hand operated ferry has plied across the Minnesota River between Mendota and Fort Snelling. It is on the last lap now, and when the magnificent new bridge is opened next fall, another link with the past will be sundered with the discontinuance of the venerable ferry.

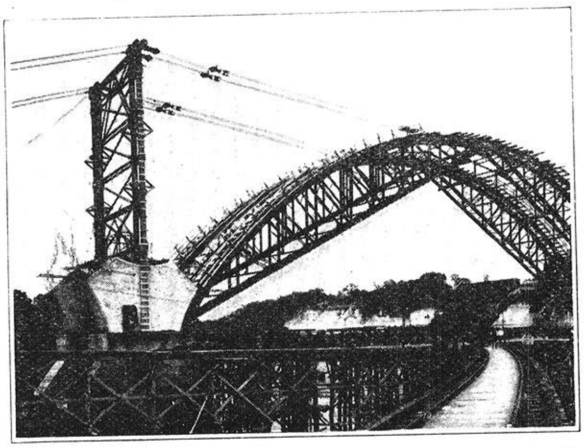
The Mendota bridge will consist of thirteen open spandrel ribbed arches, each 304 feet long with two ribs to each arch and with slab approaches at the Ft. Snelling end. It will be 4,119 feet long, 60 feet and 8 inches wide and the roadway will be 125 feet above the water level of the Minnesota River.

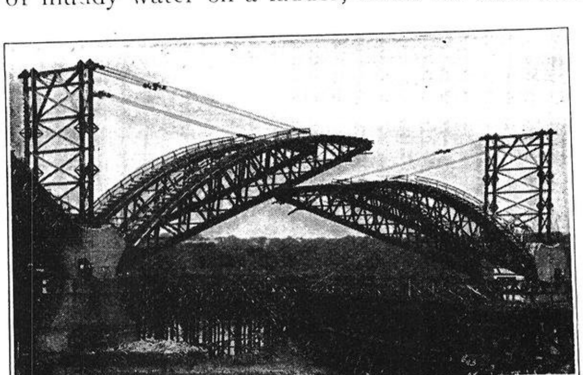
Each of the twelve piers under the main spans rests on four concrete caissons which were sunk to bed rock as concrete cylinders, built a section at a time. After being sunk to a solid bearing on bed rock the mud was dug out of the center with an orange peel bucket handled by Cranes and then the hollow center of the caisson was filled with concrete, making a solid pillar 14 feet in diameter.

The four caissons forming the foundation of each pier are tied together at the ground level with heavy web walls of concrete. At the bottom, the caissons are 22 feet in diameter, outside measurement. Thirteen feet from the bottom is an offset of four feet all around and from this offset to the top, the caissons have an outside diameter of fourteen feet and an inside diameter of ten feet—the walls being two feet thick. This enlargement at the bottom provides a broad bearing pedestal on the solid bed rock to which they are sunk. They were sunk by the open dredge method. A steel cutting edge was attached to the structural steel framework on the bottom sections of the caissons. As the excavation proceeded and the caissons sank under their own weight the sinking of each was controlled by three hand power winches of 72 ton capacities on their nine-part lines. The sinking caissons were held in line by 7-8 inch steel cables. As each section was sunk to the ground level another section was poured on top of it, sectional steel forms being used.

The caissons, each weighing 320 tons, were sunk to an average depth of seventy feet below ground level to solid bed rock. As they sank, cranes working with orange-peel buckets excavated the mud forced up through the hollow centers. This allowed water to run in at the bottom and keep them full. It was necessary that the progress at the bottom be inspected frequently, but it was found that pumping out the water to permit inspection caused the mud to come in from the sides. It was therefore necessary to hire a professional diver to do the inspecting. The contractors advertised in the daily papers for such a man and were rewarded by a reply from Pete St. Martin, a professional diver of St. Paul, whom they immediately engaged. This man would go down in the seventy feet of muddy water on a ladder, make his observations, and then report them upon returning to the surface. Acting on the information furnished by the diver they effectively directed a water jet to assist in the sinking of the caissons. However, the finding of a sloped bed rock surface at the base of one set of four caissons necessitated the forcing of cement grout with compressed air through pipes to build up an even bearing for the caissons. Other unusual conditions encountered, have been met with extraordinary engineering ingenuity and skill.


Removing the form-work from a completed arch


All ready for the center-pin. With the pin in place the two 60-foot bents on the pier skewbacks will be removed.


The steel arch centering being raised into position

All of the caissons are now sunk and filled with concrete, and the headwork on the piers is finished. Arch number thirteen is complete with deck, arch number twelve is complete with part of the deck, and arch number eleven is complete except for the deck.

The interchangeable arch centers are now in position for arches number ten and nine. The huge proportions of the Mendota Bridge may be visualized from the fact that structural steel is employed instead of wood for the arch centers, which support the superstructure during the course of construction. A complete set of these steel arch centers weighs 400 tons. There are three complete interchangeable steel arch centers.

The accompanying views illustrate the method of erecting the arch centering. Each quarter of the steel centering is placed separately in a horizontal position. The four quarters then are lifted simultaneously by eight sets of block and falls, operated by as many electric winches. The lines lead up to the tops of sixty-foot timber bents, which are strengthened with truss-cables fastened with clips, and which stand on the skewbacks of the two piers which are to support the arch. After the four quarters have been lifted to the required height, a center pin is placed in position and the winches slacked off till the pin carries the load.

(Continued on page 174)

THE PROBABLE FUTURE OF THE UTILIZATION OF OIL SHALE

By Robert A. Baxter, ch '18
*Assistant Professor of Chemistry,
Colorado School of Mines*

OIL SHALE is a peculiar kind of mineral which, though it is widely distributed over the world and found in almost every country, has been extensively used in the past in only a few isolated instances. A short consideration of where, how, and why it and related materials have been used in the past may serve as an indication of where, how, why and when it must be used more widely in the future.

Origin of Oil Shale

In the first place, it is necessary to make clear that the term "oil shale" does not mean any definite compound. Oil shale has been defined differently by almost all those who have written concerning it. The probable reason for this is that each writer has endeavored to define the shale in terms which would best fit some particular class or deposit of the material in which he is most interested. Perhaps as good a definition as any was one which was applied to stellarite or torbanite (a very rich form of oil shale) by J. W. Dawson in 1868, when he said, "It is in short a fossil swamp muck or mud." Oil shales may be massive or laminated, dense or light, and almost any color; and the organic material may be of either plant or animal origin or a mixture of the two. In fact oil shale may be anything of a pyrobituminous nature other than coal; that is, material which is not oil but which yields oil when subjected to thermal decomposition. Even this definition is not complete for it is extremely difficult to tell just where the cannel and boghead coals leave off and the shales commence. Most of the investigators now agree that coal and oil shale are materials of similar origin and it may eventually be agreed to class as oil shale all those materials in which the ratio of fixed carbon to ash in the residue from carbonization is lower than some arbitrarily set figure, and as coals all the substances in which this ratio is higher than that particular figure. At any rate there is a close relationship between these materials in the uses to which we must put them, which is a matter in which the great majority of the people are much more interested than in their origin.

Oil Shale versus Coal

Shales are scattered all over the world so that almost every country has some, though the extent and richness of the beds is far from uniform. Very few of these beds have been used to any great extent, but this is not particularly surprising in view of the fact that until comparatively recently almost all the solid fuel has been burnt as such and very little of it has been carbonized to give liquid and gaseous products and coke. As a raw fuel for direct combustion, coal is far superior to oil shale and has displaced it even when the shale beds were opened first, an instance being the shale beds in Utah which were worked by the Mormons but which were abandoned as soon as coal was discovered. The reason for this is obvious, the ash was high in the oil shales and the heating value generally low as compared to the coals.

Coal has been known for a very long time, one of the earliest descriptions of it being made by Theophrastus, a Greek, about two hundred years before the Christian era, who called it an earthy substance which would kindle and burn and mentioned its use by smiths. Coal was mined and burned by the early Romans when they occupied England but it did not come into any general use until the thirteenth century, when the mines of Newcastle were opened to a considerable extent. The fumes and smoke produced by the early inefficient forms of apparaus in which the coal was burned started the agitation against the use of coal as raw fuel which has continued to the present. As the density of population has increased and the wood available for fuel has decreased, the utilization of coal has become so necessary that the early restrictions on it seem very queer. In addition, the industrial uses of a manufacturing age have so increased that they require enormous quantities of fuel not contemplated at all five hundred years ago and only vaguely foreseen as late as a hundred and fifty years ago when the steam engine was just beginning to be applied to transportation. This increase in the demand for solid fuel which has accompanied the enormous industrial and manufacturing development of the world during the last century has had two very natural effects: the partial exhaustion of the most desirable and most readily accessible fuel materials, and the development of a steadily increasing demand for fuel for power and heating purposes. The increase in demand coupled with the decrease in the supply of the better grade solid fuels has been modified greatly in the years since the first oil well was drilled by the development of internal combustion engines and oil burners as additional sources of power and heat. In the last twenty five years there has been some degree of relief provided by the development of hydroelectric power but the amount of power thus generated is small compared to that generated from fuel. The increase in the power demand has been and must continue to be much greater than the increase in the power developed by hydroelectric means, hence we may expect that fuel will continue to become more expensive and that lower grades and new kinds of fuels will be developed and used.

Substitute Fuels

The demand for fuels has increased so greatly that already it runs far beyond the production of anthracite and high bituminous coals in the solid fuels and also far beyond the annual production of paraffin base crude oils like the oils of Pennsylvania, which not so very long ago were considered the only oils worth refining, all others being merely topped or burned as fuel oil. To supply this demand the solid fuel catgory is being increased to include lignites, brown coals, peats, municipal refuse, wood waste, and other industrial wastes as well as straw, rice hulls, bagasse (sugar cane stalks), and other such materials formerly considered a nuisance and disposed of in any way to get rid of them. Some instances of the use of these materials may be given. In the years from 1913 to 1921 the annual production of bituminous coal in Germany has decreased by 37 million tons and in the same time the production of lignite or brown coal in Germany has increased by 36 million tons. In Ireland the annual consumption of dried peat is seven million tons, of which the greater part goes for domestic fuel, though there are several factories in which it is used as fuel on a fairly large scale. Municipal refuse which was first dumped or buried was later burned in destructors or incinerators of one kind or another until in recent years apparatus has been developed to so burn it as to get some fuel value from it. Another of these formerly waste materials now an important fuel is bagasse. It furnishes all the fuel for power and cooking in most of the cane sugar factories in the West Indies at the present time, thus eliminating the need for a very large amount of coal and materially reducing the price of sugar by the utilization of this waste material as fuel.

Utilization of Substitutes

The utilization of the various kinds of low grade solid fuels which have been mentioned requires refinements in apparatus and care in operation which increases the cost and makes increasingly more desirable the use of liquid and gaseous fuels. Among the liquid fuels we have animal and vegetable oils, alcohol and related products of fermentation, petroleum and its refined products, and the liquid products of the destructive distillation of wood, coal and oil shale. Among the gaseous fuels we have natural gas and the artificial gases which we may classify in two ways: Either as to whether prepared directly as a main product such as in municipal gas works as compared with gas saved as a by-product in some industry such as gas from blast furnaces or from petroleum cracking stills; or as to method of preparation, such as oil gas, producer gas, blast furnace gas, water gas, or the gas from the high or low temperature carbonization of coal, lignites and oil shale.

It is obvious that there is a considerable degree of overlap in these methods of preparation of the various classes of liquid and gaseous fuels and there are also many degrees of overlap in their utilization, not only with each other but with solid fuels. As fuel for the generation of steam they may be used interchangeably, alternately or even together, depending on the nature of the equipment and the demand and the relative cost of the various fuels, but even here the gaseous and particularly the liquid fuels have a capacity, flexibility, convenience and ease of operation not possible with solid fuels, in spite of the fact that developments in the utilization of these materials are recent as compared to those in the combustion of solid fuel. As fuel for internal combustion engines the solid fuels are useless as compared with liquids and gaseous fuels.

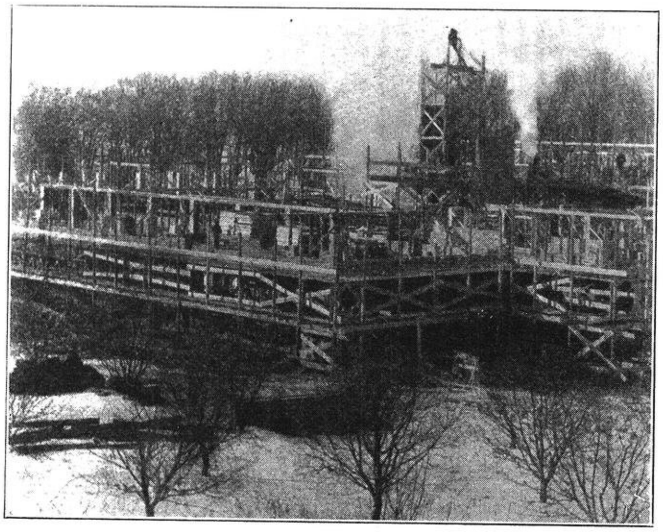
The Liquid Fuels

Of the liquid fuels, the animal and vegetable oils have been used as illuminants since before the dawn of history, but they have been almost completely displaced by mineral oils and electricity.

Among the alcohols, ethyl alcohol may be taken as an example. Alcohol has been used as a fuel in two main ways, direct combustion for heat and detonation in the internal combustion engine for power. As a heating agent it has one particularly unique use in that it may be solidified with other materials and sold as "canned heat". In this form it is a clean, compact, safe, and convenient, portable heating material and as such is likely to increase in popularity and extent of use. The burning of alcohol in the so-called spirit lamps has been fairly extensive in that here again it has been a convenient portable heating device. When the beverage difficulties of this material are finally solved it may become of much more importance as a fuel as it is valuable also in internal combustion engines. Mixtures of alcohol with ether give satisfactory performance in engines designed for gasoline, and alcohol alone gives satisfactory performance in higher compression engines designed expressly for it. In the tropical countries where vegetable growth is such that alcohol may be cheaply made and where freight rates and distance from oil refineries makes gasoline expensive, it has been used to some extent already. A further cheapening of this material thru new synthesis or thru new methods of by-product recovery may make it more important as internal combustion engine fuel, but it is not likely to materially increase in that direction as long as made from vegetables material by fermentation because there will always be great need for it as a solvent and as an organic chemical intermediate and the production cannot be indefinitely increased without using land more valuable for food crops.

Petroleum was first described by Herodotus in 450 B. C., being mentioned as occurring at Kirab,

(Continued on page 157)



The dormitory construction is well under way

BUILDING ACTIVITIES ON THE CAMPUS

By EDWARD BIRKENWALD, *Junior Civil*

AFTER a period of building inactivity, the campus is about to welcome some long needed structures. There are being constructed at the present time an addition to Bascom Hall, the Memorial Union Building, the men's dormitories, an almost completed nurses' home, and numerous smaller projects. There is also available, at the present time, money for a new wing to the Chemistry Building and a new lake pump.

The addition to Bascom Hall brings the realization of a building long sought and needed. The entire cost for the building proper plus the equipment will be $477,000. The architecture will be of the same style as the present structure. The addition is located behind Bascom, adjoining the south wing. At the present time all the excavations have been finished, the concrete foundations made, and the stone is being laid for the first story. What was formerly the noisy parking place for cars is now the noisy scene of much building activity. The addition will be ready for office and class room use next spring.

On Langdon Street across from the Library an enormous pit is being dug as the basement for the Wisconsin Memorial Union Building. The steam shovel and trucks have almost completed their work of excavating the cellar and filling in the terrace. The contract for the construction of the building will not be let until there is sufficient money in paid up pledges to finance the two units, the commons and the refectory. By placing the contract for both units at the same time, those in charge believe that sufficient money will be saved to warrant waiting for the necessary $80,000 in outstanding pledges.

Another big project under construction is the men's dormitories. These will consist of three units, two of which will house 487 students. The other, which will be a refectory, will be separate from the dormitories proper. This group of buildings is located on the drive between the lake and the Soils Building. The total cost will be $900,000, which has been financed without state aid. Of the two units facing the lake, the east unit is nearing completion. The foundations and the exterior stone work of the lower stories have been built. Men are already beginning the third story of the east unit. Work on the refectory, which is situated behind the other two units, is also proceeding rapidly. The stone for the lower story has been laid and the steel for the sky-light has been fabricated. The three buildings will be of similar architecture, Italian Renaissance, in keeping with the modified plan of Paul Cret. The buildings are being faced with Madison sandstone which has been dressed the same as in the buildings on the hill.

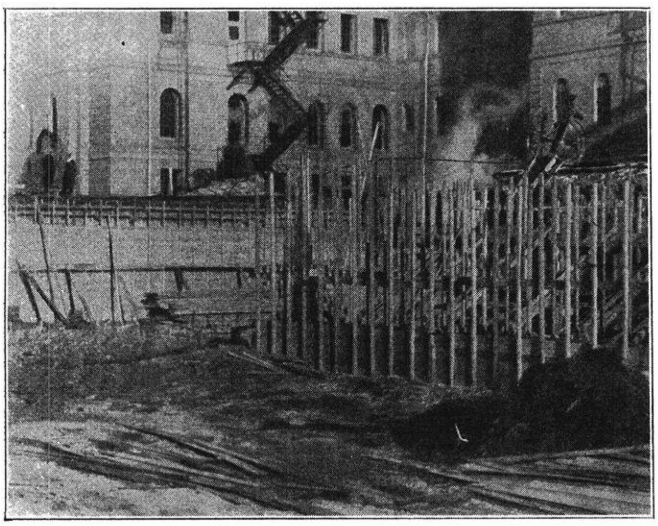
To supply the sandstone for the addition to Bascom and the men's dormitories, the local quarries, which have been in disuse for a long time, have been reopened especially for them.

The "Diggings" for the Memorial Union is nearly completed

On University and Randall Avenues the nurses' home is rapidly approaching completion. The building is of reinforced concrete, and is a fitting auxiliary to the new State Memorial Hospital. When completed, the building will accommodate ninety nurses.

To improve the service to all buildings, a new tunnel has just been completed on University Avenue. This tunnel will complete a loop with existing tunnels, and will thus provide greater safety in case of a breakdown in some section. Conduits have just been laid to the Agricultural buildings at a cost of $15,000. A new green house was just completed last fall at a cost of $18,000.

When the heating station was first built, it was planned to add another unit behind the present building to take care of the heating of additional buildings in the future. Since boilers in large units are now about fifty per cent more efficient than at the time the heating station was built; the one building will, therefore, care for the two additional boilers made necessary



The new addition to Bascom will occupy the old old parking place

by the Memorial Union Building, the addition to Bascom, and the men's dormitories.

The University is expanding not only in Madison, but also thruout the state. There has been an appropriation of $150,000 for a new extension building in Milwaukee, which will be located in the proposed Civic Center district.

Several other projects, which include an addition to the Chemistry Building, a new lake pump, a wing to the Library, and a Field House, are about to be realized. The new wing to the Chemistry Building, which will cost $390,000, which sum represents a $90,000 hang-over and a $300,000 recent appropriation, will make the building symmetrical with respect to the entrance. Work will be started soon.

If the funds are sufficient, a $550,000 addition will be made to the library in July 1927. An appropriation of $12,000 has already been made for a new lake pump to take care of the additional supply for the new buildings.

On the corner of Breese Terrace and University Avenue there will soon be built a mammoth field house for Wisconsin's indoor athletics. It is significant that the financing of this building, as well as the two other major building operations, the Memorial Union Building and the men's dormitories, has been without state aid.

UTILIZATION OF OIL SHALE

(Continued from page 155)

Persia. Oil springs and seeps were worked for oil, mainly for medicinal purposes, at many places over the world and small amounts were used as burning oil, but it was not until the middle of the last century that any serious effort was made to obtain or use petroleum. Since Colonel Drake put down his sixty-nine foot hole at Titusville, Pennsylvania in 1859 and got a twenty-five barrel pumper the development has been prodigious until at the present time, the petroleum industry is one of the great industries of the world. The oil was originally refined with the main products being kerosene and wax, but the development of the automobile has changed this so that now the chief products are gasoline and lubricants. In addition to the gasoline which serves as automobile fuel, the kerosene which serves as burning oil and as Diesel engine fuel, and the gas or fuel oil fractions cut in various ways in the complete refinery, there is much of the lower grade crude oil which is used directly as fuel oil or is topped to yield gasoline and fuel oil. These products are all so widely used and so well recognized that it is unnecessary to detail their uses other than to call attention to the fact that particularly the gasoline used in automobiles is still a rapidly increasing demand and likely to continue to increase in the future. In view of the fact that the consumption of crude oil was six hundred and fifty million barrels in the United States alone in 1924, and also in view of the fact that the United States is far ahead of other countries in this demand for petroleum and that consequently the demands of the rest of the world are likely to increase very rapidly in the future, it is well to consider petroleum resources. Estimates of the potential production of present wells in the United States vary from 1500 to 3200 million barrels and the most optimistic estimates of undeveloped petroleum in the United States by present methods is 2100 million barrels or a total of only about eight years supply at the present rate of consumption even if it could be obtained in that short time. It is interesting to note that in the so-called American Petroleum Institute Report issued by the Committee of Eleven last summer the estimates of oil producible from coal, lignite, and oil shale were about twenty times the estimated petroleum or well oil reserve. This estimate is particularly interesting in

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CONCRETE COLUMNS

(Continued from page 149)

The strength ratios for columns having ¾-inch rods show that the butt-splices were generally more efficient than the lap-splices. However, the full column strength was developed by the 40 diameter lap-splices.

Effect of Time Loading

The time loading data (taken on columns O-2, P-2, Q-2 and R-2) indicated that these columns gradually deformed under the continuously applied 200,000-pound load. This was equally true of the splice and outer gage readings. Also, the static load condition, effective for a period of 4 hours, decreased the strength of these specimens below the values obtained on companion columns tested without such a delay.

Examination of Specimens after Test

After testing, the splices in each column were exposed by chiseling away the surface concrete. This was done to indicate whether the rods had slipped and also whether the splices had moved out of position when the concrete was tamped into place. In the lap-spliced columns slipping and separation from the concrete at the embedded ends was usually noticed. It was found in a number of cases that the concrete at the end of the rods had failed with a typical conical shear fracture. In several cases the spiral reinforcing wire failed in tension due to lateral bulge in the concrete. Typical failures of these columns are shown in Figures 3 and 4.

Summary and Conclusions

1. Visual observations and numerical results in this investigation verified the accepted idea that spiral reinforcement in concrete increases its strength by resisting lateral deformation.

2. Efficient splices are more readily made with small rods than with large rods. This is demonstrated by the higher percentage ratios for the columns made with ½ inch splices (Table 1).

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TABLE I
SUMMARY OF TESTS

Column No.	Longitudinal Reinforcement No. Rods	Reinforcement Size	Percent Reinforcement	KIND OF SPLICE	Strength of Cylinders Ave.	Ultimate P/A Net	Ultimate P/A Ave. Net	Percent of Strength B-1-2
1	2	3	4	5	6	7	8	9
B 1	6	½	2.58	None	4292	6300		
B-2	6	½	2.58	None	3040	5425	5863	100.0
D-1	6	½	2.58	Pipe Snug, End Sawed	3968	6625		
D-2	6	½	2.58	Pipe Snug, End Sawed	2950	5580	6103	104.0
F-1	6	½	2.58	Pipe Snug, End Sheared	3903	6385		
F-2	6	½	2.58	Pipe Snug, End Sheared	2787	5580	5983	102.0
H-1	6	½	2.58	Pipe Loose, End Sheared	4417	5950		
H-2	6	½	2.58	Pipe Loose, End Sheared	2808	6280	6115	104.2
J-1	6	½	2.58	2-inch Lap, End Sheared	3948	5660		
J-2	6	½	2.58	2-inch Lap, End Sheared	2968	5340	5500	93.6
L-1	6	½	2.58	20 dia. Lap, End Sheared	4322	6380		
L-2	6	½	2.58	20 dia. Lap, End Sheared	2908	5930	6105	104.0
N-1	6	½	2.58	40 dia. Lap, End Sheared	3797	6150		
N-2	6	½	2.58	40 dia. Lap, End Sheared	3222	5775	5963	101.7
								Percent of Strength C-1-2
A-1	None			None	4292	5035		
A-2	None			None	3040	4920	4978	69.8
C-1	6	¾	5.80	None	3968	7000		
C-2	6	¾	5.80	None	2950	7245	7123	100.0
E-1	6	¾	5.80	Pipe Snug, End Sawed	3903	7215		
E-2	6	¾	5.80	Pipe Snug, End Sawed	2787	7220	7218	101.3
G-1	6	¾	5.80	Pipe Snug, Sheared	4417	7040		
G-2	6	¾	5.80	Pipe Snug, Sheared	2808	6435	6738	94.5
I-1	6	¾	5.80	Pipe Loose, Sheared	3948	6955		
I-2	6	¾	5.80	Pipe Loose, Sheared	2968	6800	6878	96.5
K-1	6	¾	5.80	2-inch Lap, Sheared	4322	6135		
K-2	6	¾	5.80	2-inch Lap, Sheared	2908	6540	6338	88.8
M-1	6	¾	5.80	20 dia. Lap, Sheared	3797	6100		
M-2	6	¾	5.80	20 dia. Lap, Sheared	3222	6820	6460	90.7
O-1	6	¾	5.80	40 dia. Lap, Sheared	3717	7500		
O-2	6	¾	5.80	40 dia. Lap, Sheared	2473	7000	7250	101.9
P-1	6	¾	5.80	2-inch Lap	3717	3750		
P-2	6	¾	5.80	2-inch Lap	2473	5300	6025	84.5
Q-1	6	¾	5.80	20 dia. Lap	3658	6280		
Q-2	6	¾	5.80	20 dia. Lap	2562	6435	6358	89.4
R-1	6	¾	5.80	40 dia. Lap	3658	7000		
R-2	6	¾	5.80	40 dia. Lap	2562	6850	6925	97.2

Engineering Review

R. A. MILLERMASTER

INGENUITY

The human mind outwitted nature recently near Pueblo, Colorado, when a bridge contractor constructed a 100 foot steel bridge on the river bank and then pulled it into place.

Workmen, on two occasions, constructed the piling and falsework upon which to build the superstructure, as is usually done in bridge building. On both occasions the creek became swollen with flood waters and washed out the falsework, just as the steel work was started.

Workmen then built the entire bridge on the roadway. When it was completed they constructed the falsework again, and pulled the span into place before another flood had an opportunity to wreck the piling. Timbers were greased and the steel span pulled into place by means of a large tractor on the other bank. Only an hour was required to install the bridge which was then bolted to the concrete abutments previously poured. —*Scientific American.*

WORK STARTED ON LONGEST TUNNEL

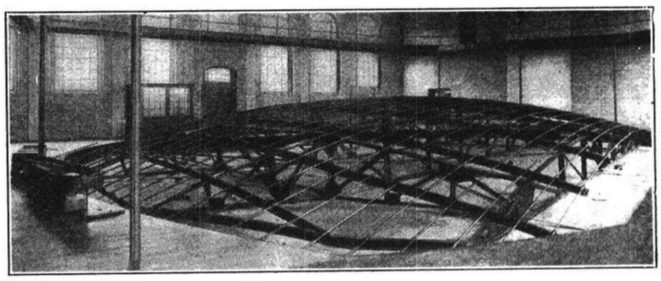
The Great Northern has awarded a contract for the construction of a change in its main line thru the Cascade Mountains, approximately 100 miles east of Seattle, that involves the driving of a tunnel 7.75 miles long—the longest railway tunnel in America. The present line, which was built in 1892, crosses the divide at an elevation of 3385 feet above sea level. It has sharp grades and curves, numerous snow sheds and several tunnels, the longest of which is 13,873 feet in length. On account of the heavy snowfall, which reaches a maximum in a single season of 410 inches at Berne and 670 inches at Cascade tunnel, it is difficult and expensive to keep the line open for operation. Many studies have been made in an effort to secure a new location with a longer crossing that would avoid the snow trouble. The increasing importance of a thoroughly dependable line, the fact that additional sheds were required to keep the present line open, and the heavy repairs required annually on existing sheds and tunnels brought expenditures to a point where a new line would show a substantial saving.

The new line, as located, will shorten the distance more than 7½ miles, eliminate nearly six complete circles of curvature, and will escape most of the severe snow trouble. It involves the construction of a single track tunnel 16 feet wide, 22 feet above top of rail, and 7.75 miles long. The estimated cost will be $10,000,000.

ENORMOUS RELIEF MAP WILL SHOW TRANSPORTATION LINES

Considerable interest has been aroused in a 65 foot relief map of the United States and Canada now being constructed in the Coleman Building at Babson Park, Mass. Various methods of transportation, — steam, electric and highway — will be featured on this map.

The map will represent a section of the earth's surface with a scale of ¼ inch to the mile. From coast to coast it will measure 63 feet and from north to south 46 feet. Corresponding to the natural curvature of the earth, the map-center will be 7 feet higher than the edges representing the Atlantic and Pacific coast lines.



As shown in the accompanying photograph the map will be supported by a steel frame work which will maintain rigidly the exact contour representing the earth's surface. Upon this steel framework will be mounted slabs 35 x 30 inches constructed of a special plaster. When mounted on the steel framework these slabs will be cemented together to form a continuous surface. An elevated gallery is provided around the room so that the map can be viewed from all sides. The Coleman Building, especially constructed to house this master map, will provide shelter for many other auxiliary maps to larger scale of small sections of the country. —*Elect. Railway Journal.*

ENERGY OF MUSCLE SHOALS EXAGGERATED

Our present day available energy and that which we plan to make available in the future cannot be altogether credited to water power, not even the major part of it. Water power, by itself, could not, except at tremendous cost, have made possible the energy we are transmitting to all corners of the land. Without the backing up by steam, so that in times of drought our service may be dependable, water power would be of doubtful value. This is said in controversion of the fallacy that many would spread about that water power is some "super" thing—some wonderful force of nature, always ready and willing to do our bidding. Without

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IT COSTS SOMETHING TO CREATE A GOING CONCERN

Is it fair to expect a man who has spent four years of hard work and a considerable sum of money in studying technical engineering to go to work for fifty cents an hour? The question is raised by a senior who is beginning to think of the future immediately ahead of him. It has suggested an analogy between the newly graduated engineer and the man who has just gone into business. The latter knows that, even though he has invested just as much money as an established competitor may have done, and even though he works as hard or harder, his earnings for a time will not be so great, — in fact, he may have to operate at a loss for a time. Eventually, he expects to become established and to make up his losses. The money loss incurred in the early months or years of a business constitutes a recognized part of the cost of development. When a going concern changes hands, the sale price is always placed well above the value of the physical plant in order to cover the cost of building up the business.

The graduate engineer faces the task of making a going concern of himself, and the mere fact that he represents a considerable investment in time and money will not relieve him of the necessity of going through the development period. Not many of the graduates are forced to operate at a loss during the time that they are establishing themselves. In that respect they have an advantage over many business men and over many other professional men.

"The Courage of the Commonplace is greater than the Courage of the Crisis." —Mary Shipman Andrews.

WELL TIMED REPAIRS

It was eight-thirty o'clock, Wednesday morning, January 27 of this same year. In Room 201 of our engineering sanctum, the senior mechanicals were earnestly laboring with an exam in alternating currents. Suddenly a heavy bombardment shattered the intense silence; some worthy was hammering on the ventilating duct leading into the room. For a period of fifteen minutes the bam! bam! roared into the room, utterly destroying any thoughts of third harmonics, line reactance, or core loss. It seemed as though no human arm could so long maintain such a succession of blows, but the man behind that hammer was second only to Hercules himself. Whoever arranged repairs for that time certainly co-operated with the intricacies of electrical engineering in upsetting thought. Mr. Chairman of the House Committee of the Engineering Building, may we have reasonable quiet at such times?

A FRESH PAGE

Unlike his accomplishments in life, one has a chance to entirely change his works and attitude twice in each school year. The closing of the previous semester permanently shuts off any chance of change in the work done in that term: it was poor, mediocre, or good, and nothing can now revise it.

But likewise the new semester lies open before one, like a clean, new page of a diary or log. In June, what will be recorded on that page? Time will be the recorder, but the one who directs the pen will be the student himself. He can do only three things: go down, stay on the same level, or go up. The record on the page may show that he has squandered time, grown indifferent, bellicose, and lazy, and learned nothing. It may indicate that he has been satisfied to shuffle along in the same manner, bumping through quizzes and finals, content that he is getting by and that is all one could desire. Or will it show that he has worked thoroughly and well, learned a little more than that required in the classroom, and prepared himself to be a real engineer?

SALES ENGINEERING

It is often a far cry from the work our engineers finally drift into after graduation to the vocation they saw ahead of them while in school. Supposedly astute scholars laboriously fit themselves for research or design before June — and August finds them turning toward salesmanship or fitting themselves for other executive positions.

Was their technical education in vain? The writer thinks not, for a man must be well grounded in the fundamentals for even the commercial aspects of engineering. And the diligent student of calculus becomes the capable executive with extreme facility. We do not urge a drastic change in the engineering curriculum, but we wish to bring before the undergraduate engineer the commercial field as an exceedingly possible opportunity.

One large manufacturing company is taking on as many engineers for sales work as for purely engineering — application, design, research — phases of industry. And many more are recruiting their sales forces almost wholly from the ranks of the technical schools. Our embryo graduates are therefore advised to consider carefully the commercial field as an outlet for their capabilities and ambitions.

The men who design and make — the men who buy and operate — engineering equipment have technical

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Campus Notes

POLYGON ELECTS 1926 OFFICERS

R. E. Zinn, ch'27, was elected president, and W. Z. Lidicker, c'27, secretary-treasurer, at a meeting of Polygon which was held January 15. Polygon is the student executive body or steering head of the College of Engineering in the supervision of events which concern the engineering student body as a whole, for example, the Engineers' Dance, and St. Patrick's Parade. It is composed of one junior member and one senior member from each of the five engineering societies, who are elected by their respective societies for a term of one year.

The present members of Polygon are R. E. Zinn, ch'27; R. E. Harr, ch'26; W. Z. Lidicker, c'27; J. P. Smith, c'26; J. C. Verner, m'26; M. J. Williams, m'27; R. C. McCoy, e'27; O. E. Anderson, e'26; F. J. Sonday, min'26; and P. P. Whittingham, min'27.

The other day the boys went to sleep in one of Charlie Corp's one-thirty lectures. The "Daily Dozen" of our grade school days brought us back to attention.

ENGINEERING CLASSICS

C. L. Neumeister—"As a matter of fact - - - -."

"Jimmie" Watson—"Obviously, that is correct."

Louis Kahlenberg—"That's the bunk, gentlemen. Too much red tape."

"Bill" Kinne—"Follow the book."

"Ev" Schuman—"There's nothing to it if you'd only draw a free body diagram."

"Charlie" Corp—"Considering the fact, men, that —."

NEW COURSE OFFERED IN METHODS OF INDUSTRIAL RESEARCH

A personally conducted course in Methods of Industrial Research is being offered this semester by Prof. R. S. McCaffery, of the course in mining engineering. The course will comprise (1) class room discussions on the basis of the problems, (2) four trips to four Milwaukee industrial plants at different intervals, during which data will be taken on some particular phase of the research project under way at each plant, and (3) a written report and discussion of the results obtained during each trip.

Prof. R. S. McCaffery has just received the following notice of his election to membership in The Blast Furnace and Coke Association of the Chicago district:

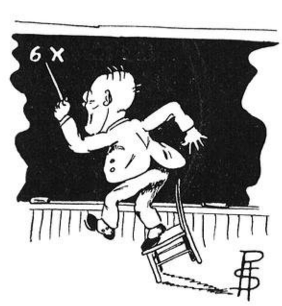
"Due to your very commendable work with blast furnace slags, The Blast Furnace and Coke Association of the Chicago district, wishing to show its appreciation, has elected you an honorary member."

(Signed) GEORGE E. STENDEL,
Secretary-Treasurer.

NEW OFFICERS INSTALLED AT A. S. C. E. MEETING

The last meeting of the semester of the A. S. C. E. was held January 14 for the purpose of electing and installing officers for the second term. The new officers of the society are R. J. Plitz '26, president; L. W. Empey '26, vice-president; and W. Z. Lidicker '27, secretary-treasurer. Prof. C. I. Corp, of the hydraulics department, who has kindly consented to act as advisor to the society in the matter of programs and general procedure, spoke briefly to those present on the manifold opportunities for self-improvement which exist for members of the society. Announcement was made at this meeting of prizes which are to be awarded each Spring to the civil engineering seniors who will have done the best undergraduate work in Structures and allied subjects. A committee was appointed by the new president to make arrangements for a banquet to which special invitations will be extended to the junior and senior civil engineering students, and at which a representative of the Association of Structural Engineers of Milwaukee, the donor of the prizes, will address the gathering on the opportunities in the structural field.

"Danny" Mead threatens to obtain an injunction to prevent the rest of the faculty members from "absorbing" his long pointers. He was considerably *put out* the other day when he had to mount a chair in order to point out some figures on a chart.



In a matter of six weeks or so, our old friend, St. Patrick, is due to arrive in these parts for his annual visit. To insure his getting a real honest-to-goodness reception, and to forestall any possible machinations of our legal adjuncts, we hope that the engineers will forwith begin laying their plans for St. Pat's Parade.

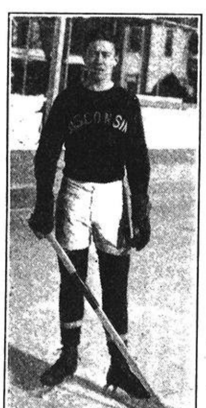
Athletics

B. R. Teare

HOCKEY

Far from being now considered an uninteresting, poorly attended, and losing sport, hockey has risen from this position to that of a top-notch game. In other years, Wisconsin has finished near the bottom of the heap, but this year shows a marked change. Some excellent material is reporting for the team, much of it from the College of Engineering, and under the excellent guidance of Kay Iverson, coach of outdoor winter sports, it has been developed into a high speed conference team, able to make a good showing with the best of teams. Coach Iverson has not had an easy time of it, however, for none of the men, except Captain Gross, had even played on a conference team before, and they had everything to learn.

"Bill" Lidicker, junior civil, has done especially fine in the wing position, and his cool head and well-aimed, dependable shooting has meant much in making the team's fine showing. Improving, as he is, in the future he will be even more valuable. Whiteside, a senior civil from Canada, too, has had his share in the Wisconsin triumphs, serving in either defense, center or wing positions. Due to exam fatalities he will be given a greater chance to show his ability, as will Ruf, junior civil, who plays a strong defense game. Backing these men and showing up well in the games are "Spike" Carlson, senior civil, Britton, junior electrical, and Cahoon and Carrier, sophomore mechanicals. The manager, Schwan, is also an engineer, a sophomore civil. Other promising plumber material include Mathews, Reinke, Dahlman, Breiby, Mackin, Maxfield, and Troye and Dahl, frosh ski whizzes.

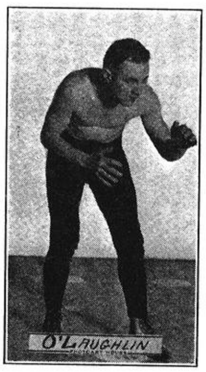


Whiteside,
Senior Civil.

Returning in good shape from their training trip into Northern Minnesota the team prepared for the matches with Marquette. The Milwaukeeans were not very strong, especially in defense, and the Badgers romped over them to the tune of 11-0, and 3-0, almost all of the scores being made by Whiteside and Lidicker.

On the following week end, a real hockey match took place with Minnesota, whose team usually walks off with the conference honors in hockey. Coach Kay Iverson's team proved fully the e q u a l of his brother's Gophers for the two fast games ended in ties, the first 0-0, and the second 1-1. The single count for Wisconsin was made by Lidicker, shortly after Minnesota's was made. These ties, considering the rating of the opponents, and the fact that this year's team is one of the best, are almost as good as victories for Wisconsin. Coach Emil Iverson of Minnesota was certain of victory and could scarcely believe his eyes — every place he looked he said he could see a redcoat, and he counted them to make sure that his brother was not playing too many men.

WRESTLING



O'Laughlin,
Junior Electrical

Engineering grapplers, who make up a large percentage of the squad, showed up very well in the Iowa meet, even though Captain Zodtner, senior chemical was with the injured. Bill Splees, junior electrical, did fine work winning his match in the 158 pound class; Wally Cole, sophomore chemical, showed up very well in his first conference meet, winning his bout. Mike O'Laughlin, junior electrical, demonstrated speed and real ability when he all but won his match, and Chao, sophomore civil, also did excellent work. Zodtner, Splees, and Cole, are among the most outstanding wrestlers on the squad, and will doubtless be strong contenders for individual championships in their respective classes, according to Coach George Hitchcock, who himself spends part of his time as an engineering instructor.

This is not the whole extent, however, of the engineers' participation in wrestling, for many others are doing their share to advance the sport. In the 115 pound class are Meusen, Groth, Schmidt, Tanner, and Stetson; in the 125 pound class, Zola, Robarge, and Randecker; in the 135 pound class, Suehs, and Millard; in the 145 pound class, Feldhausen, Bagnall, and Sewell; and in the 175 pound class, Brackett, Fiebrantz, and Horsfall.

Wisconsin may well be proud of the wrestling team this year. The showing made in the sport is very good, considering that the time and attention given wrestling here is not as great as that at other schools in the conference, and much of the credit should justly go to the coach, who is an adept at the sport. Since a goodly amount of material is out, injuries cannot seriously cripple the team, and with the men all showing true Wisconsin spirit, the future of wrestling is assured.

Alumni Notes

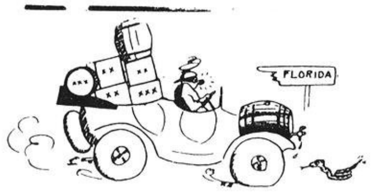
CHEMICALS

A. C. Vobach, ch'21, has changed his address to 411 Sheridan Ave., Whiting, Ind.

CIVILS

Benjamin F. Ahrens, c '23, is now residing at 318 S. 8th St., La Crosse, Wis.

Herman Blau, c '20, is reported to be working on the subway in New York City. His present address is unknown.



L. J. Busby, c '25, left in February for Miami, Fla., where he will be engaged in building construction with Millard B. Smith. Address: Seminole Hotel, 53 E. Flagler St., Miami, Florida.

Harold E. Crider, c '21, is living at 1100 South Ave., Wilkinsburg, Penn.

Alden C. Fensel, c '23, writes, "After leaving college, I took a year of post-graduate work at the National Institute of Public Administration in New York. I am now the engineering staff member of the Municipal Research Bureau of Cleveland. Prior to this, I served as assistant to the manager of the city of Ashtabula."

Paul C. Gillette, c '18, is with the firm of Barker & Wheeler on the valuation of public utilities. His present address is % M. Harry Barker, 90 West St., New York City.

N. M. Isabella, c '14, maintenance engineer with the Wisconsin Highway Commission, addressed the Chicago Regional Planning Association in Chicago recently. Highway officials from all the territories interested discussed plans for providing the Chicago region with highway facilities.

Hugh Kent, c '14, is with Consoer, Older & Quinlan, Chicago. He has charge of the work at Franklin and Schiller parks.

H. A. Marshall, c '15, is Consulting Engineer with offices in the Smith Building, Topeka, Kansas.

Cecil R. Russell, c '23, writes from Christchurch, New Zealand, to Professor Owen, I am using a Best '45' Super-het and get California on the loop on phones and Australia, 2000 miles away, on loud speaker. The set uses 4 UV199 tubes and 4 201-a tubes, otherwise is standard. It's the best set I ever had."

N. A. Saigh, c '15, sends his business address as 511 Builders Exchange Building, San Antonio, Texas.

Millard B. Smith, c '25, left in February with L. J. Busby for Miami, Fla., where he will be engaged in construction work. Address: Seminole Hotel, 53 E. Flagler St., Miami.

Earl A. Solomon, c '24, visited the college on February 8 and announced that he is with the Dixie Concrete Products Co. at Chattanooga, Tenn.

Milton C. Steuber, c '16, and associates have opened an office for consulting practice in structural engineering at 405 Fulton Building, Pittsburgh, under the name of National Engineering Services, Inc.

E. R. Stivers, c '15, is now teaching in Robert College, Constantinople, Turkey. He writes an exceptionally interesting account of some of his experiences. "Leaving New York on the S. S. Republic on August 12 we headed for 'Merrie Auld England' which we reached on the ninth day after an extremely pleasant voyage. We touched at Plymouth and then at Cherboug, where we landed.

"My impression of Turkey — a primitive country but an earnest one, rich in resources but poor in capital, weak and therefore imposed upon, and grossly slandered. It is not half so bad as it is painted. The massacres of which it has been guilty have not been religious primarily, but political and usually have been provoked by its victims.

"The college has a registration of about six-hundred plus; the engineering school, 140. This semester I have the juniors in all of my subjects, mechanics, 13, surveying, 5, railway curves, 6. In these classes are Greeks, Turks, Albanians, Russians, Armenians, and Jews. They all speak excellent Eglish. So far I have found them better prepared in mathematics, etc., brighter in class and duller in field work than the American student if we take Wisconsin as an example." Mr. Stivers can be reached % Robert College, Constantinople, Turkey.

L. T. Sogard, c '24, a former editorial writer of the Wisconsin Engineer is the author of an excellent article on "Trucking Within the Construction Lines of a Road Job" that appears in Engineering & Contracting for January 6. Larry evidently intends to apply the training in writing that he received on the Engineer and in Van Hagan's course in Engineering English. Larry is with the Illinois Central Railroad Company, and his address is Box 599, Murphysboro, Illinois. He writes, "Wisconsin's reputation had already been well blazed down here by our friend Moxon, c '22, who "inspected" up and down this division for over two years; and I have found that I have much to live up to. Everybody, from the supervisor to the baggageman, swears by him."

The following senior civils completed their work in February and have taken positions as indicated:

Bonawitz, Walter G., with the city engineer of Milwaukee.

Bloodgood, Don E., address, Route 1, Elkhorn, Wis.

Engelke, Arnold J., with the Highway Commission at La Crosse.

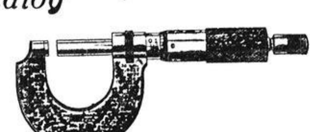
Francis, Chester J., in the hydraulic engineering department of the Wisconsin Power & Light Co., Madison. Address: 606 University Ave.

MacLeish, K. C., instructor in Agricultural Engineering, University of Wisconsin.

Molzahn, Harold, with father in general contracting at La Crosse. Address: 402 South 19th St., La Crosse.

Quinn, Raymond J., in the contracting business with his father. Address: 821 W. Dayton St., Madison.


THE LUFKIN RULE CO.
50 FT.
ENGINEERS TAPE



Saltzstein, Irving D., with Vacorro Bros. of New Orleans as engineer on their fruit plantation in Honduras.

Zufelt, Jerome C., with Consoer, Older & Quinlan of Chicago.

Phelps, Ivan, with I. C. R. R. on terminal improvements at Chicago.

ELECTRICALS

Howard Aiken, e '23, results engineer with Madison Gas and Electric Company, is again back on the job after having tried to form one terminal of an electric arc. Aiken came in contact with a high voltage wire which put him "Hors de Combat" for a short time. He is again in good shape and proceeding with his work of superintending the installation of a new switch board at the gas plant. He is living at 915 Spaight Street, Madison.

Paul B. Best, e '12, has changed his address from 16509 Endora Road to 1824 Torbenson Drive, Cleveland, Ohio.

P. G. Bowman, e '22, can be reached at 13 Bedford Road, Schenectady, N. Y.

W. E. Dick. e '22, sends us his address as P. O. Box 122, Ripon, Wis.

Fred H. Dueno, e '24, is working in Cincinnati with the Westinghouse Electric & Mfg. Co. is in the service department. He enjoys the work very much as it brings him into contact with the more important electrical work going on in that vicinity. He was employed on the Columbia Park Power Station with the switchboard work which Westinghouse installed in this new and highly efficient central station. Dueno can be reached in care of Westinghouse Electric & Mfg. Co., Third and Elm Sts., Cincinnati, Ohio.

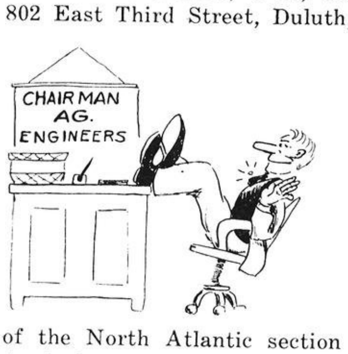
A. F. Krippner, e '04, is residing at 760 Downing Street, Denver, Colo.

Henry A. Lardner, e '93, E. E. '95, sends his new address as 9 Bradford Ave., Upper Montclair, New Jersey.

W. R. McCann, e '15, formerly with Stone & Webster of Boston, is now with the Atmospheric Nitrogen Corporation located at Buffalo, N. Y.

Roy C. Muir, e '05, is at home at 102 Avon Road, Schenectady, N. Y.

Leslie V. Nelson, e '17, sends his present address as 802 East Third Street, Duluth, Minn.



R. T. Wagner, e '05, is with General Electric at Schenectady. The following article appeared in one of the recent Eastern papers: R. T. Wagner, a resident of this city and a representative of the central station department of the General Electric Company of this city, was chosen chairman of the North Atlantic section of the American Society of Agricultural Engineers at the closing session of the convention held Saturday morning at the Hotel Van Curler.

The North Atlantic section of the society of which Mr. Wagner is the new chairman includes all territory in eastern Canada and the eastern states of this country as far south as Virginia."

The Wisconsin Engineer wishes to congratulate Mr. Wagner on his recent election and wish him success in his new position.

Paul T. Norton, e '17, has changed his address to 1534 Inglis Ave., Columbus, Ohio.

A. N. Outzen, e '10, has changed his address to Supt. River Rouge Co., 415 Clifford St., Detroit, Michigan.

L. P. Richmond, e '23, sends his address as 21 Governor's Lane, Schenectady, N. Y.

Duncan J. Stewart, B. A. '20, e '21, sends his address as 214 Franklin Place, Rockford, Ill.

Vincent A. Thieman, e '25, who is with the Westinghouse Electric & Mfg. Co. at Pittsburg visited the school recently for a week's stay. He enjoys his work very much at Westinghouse, and is "sold" on the idea of salesmanship in engineering.

Yussuf Zia, e '24, writes, "In your last January issue I read a few lines about where I was heard from last, but now I want to let my friends hear from me again that I have come back to "Good Old U. S." on August first of 1925, and I have been working for Westinghouse Electric & Mfg. Co., at its East Pittsburgh factories. Now I am in testing department and testing transformers and oil circuit breakers. My present address is: The Westinghouse Club, Wilkinsburg, Penn." Zia expects to work with Westinghouse International in export business later.

W. C. Wu, e '23, can be reached at % New York Edison Co., 44 E. 23rd St., New York City.

MECHANICALS

Chas. F. Bleyer, m '07, can be reached at 2507 E. Erie Ave., Lorain, Ohio.

Arthur W. Edwards, m '25, is with the Trane Co. at La Crosse. He writes, "We fellows all find that this business of keeping people warm is interesting."

Earl Hanson, m '22, is with the Gillette Camera Stores. He writes, "I sail in the middle of January on a Cook's tour of the Mediterannean, a job that will not only be a welcome change after my three hectic years in Chile, but will give me some fine chances for free-lance journalism.

My South American years were great experience. The Chile Exploration Company wanted me to go back on another contract, but three years in the world's worst desert is enough. I happened to be lucky there in that work took me all over the place, from the power plant on the coast to the water intakes on the Bolivian border. I was continually going on mule rides, on inspection trips and repair work, and got to know the country well. Eight months in charge of construction camps, driving 200 demented loafers and 30 mules and a couple of tractors to building one section of a long road and pipe-line, were the most strenous and valuable of my life. — — You may tell Pat Hyland that he was all wrong when he told me I'd end up as a fat chief-engineer in some third-rate power plant." Hanson's address is 7 W. 65th St., New York City.

Lane W. Hildreth, m '24, is with the Atlantic City Gas Company, Atlantic City, New Jersey. He writes, "For the last year and a half I have been working for the Lansing, Michigan Gas Co. in their distributing and manufacturing departments and have just come to Atlantic City where I am to work into a job as a heating engineer sometime in the future. As you know, I have very little knowledge of heating and will have to study up a lot before I can be of much value as a heating engineer.

All our work here will be with gas fired boilers for hot water and steam, and with the Clow Gasteam radiators."

Don McArthur, m '23, is with the Merrillville Lumber & Supply Co. of Merrillville, Indiana. He writes to Professor Larson: "The retail lumber business has been almost nil for the last month out here but that has given me time to get the garage business started. We got the shop building finished about a month ago and after the usual delays in getting everything set up we started to make some sections last week. Everything looks fine while it is apart, but tomorrow we have the real test as we expect to erect the first one. Then is when it will be seen how theory and practice correspond. It looks O. K. on paper."

I like this work fine. It isn't so much the exact thing that I like but the idea of being in something small enough to show my initiative. Everything is up to me except that the president of the company bought the lumber. As he is going to Florida for the next six weeks that leaves me pretty much to myself."

Carl S. Reed, m '05, is living at 191 Park Ave., Yonkers, New York.

Emil F. Stern, m '19, has changed his address to 1341 Estes Ave., Rogers Park Station G, Chicago, Ill.

MINERS

Ernest Schwartz, min '18, is melter at the new Open Hearth plant of the Wisconsin Steel Company at South Chicago. With the newest and most modern plant in the Chicago district, and with Schwartz to run it, Wisconsin Steel should make a very fine product. **Joe Woschutz,** min '23, is working with Schwartz. **H. P. Howland,** m '03, is in charge of the blast furnaces and of the By-Product Coke Plant of the same company.

Lloyd M. Scofield, min '21, is geologist for the Pickand-Mather Company with headquarters at Newport Mine, Ironwood, Michigan.

ENGINEERING REVIEW

(Continued from page 159)

man's ingenuity and without supplementation by steam, water power at times would prove a faithless servant. We all know that our own Muscle Shoals—that is, the energy that it will generate—has been grossly exaggerated and overstated. It is a well known fact that, at times, except with steam support the power that can be developed there will run well under 100,000 horse power and that the yearly average will range very little above that figure,—not 450,000 to 600,000 horsepower as has many times been stated. Then too, water power without a market is of little value. Gold would be dross if there were nothing to buy.

Ninety per cent of our population lives east of the Rocky Mountains with only 25% of our developed and undeveloped water power in that same territory. A hundred and more years from now there will still be water running to waste, if that is the proper term to use, on the Pacific Coast, for the good and simple reason that there will not be a market for the electricity it would produce if harnessed and put to work.

—*Engineering.*

ECHO DEPTH SOUNDER

A device attracting general interest is the Behin echo-depth-sounder. This device, an invention of the German physicist Herr Behin, is designed to enable soundings to be made at sea by noting the time interval taken by a sound to travel from the surface to the bottom and thence to return as an echo. The true basis of the invention is an instrument capable of measuring time down to the thousandth part of a second. This instrument is at any point on the ship and is connected to a firing head and two microphones. When the firing head control on the instrument is operated a cartridge is ejected from the ship's side. This cartridge is fitted with a delay action fuse and explodes when it has descended through a few feet of water. The noise of the explosion is caught by one of the microphones which operates a relay that starts the action of the time interval recorder. The echo from the bottom is shortly afterwards received by the second microphone, which acts to stop the recorder. From the known velocity of sound in water, the scale of the recorder may be graduated to read directly the sounding in feet or fathoms. The two microphones are placed inside on opposite sides of the ship's hull to prevent the echo-receiving microphone from operating under the sound of the explosion which sets the starting microphone to work. In some instances where this shielding effect is not available, the echo-receiving phone is fitted with an arrangement which momentarily throws it out of action as the cartridge is fired. The device is applicable to sounding in air also. It was employed during the trials of the Zeppelin airship Z-R3 before she left Germany, and worked satisfactorily for all speeds up to 62 miles per hour.

EDITORIALS

(Continued from page 160)

ability — why not the other link in the chain — the salesmen? Then we would not have any foolish blunders like the one made by the sales promoter (not an engineer) who, when asked by a prospective customer about the core loss of his motor, stated glibly, "Our core loss is just as large as that of any of our competitors."

In many ways the work of the salesman in engineering is as important as that of any of the regular engineers. It is his privilege and duty to help the customers get the maximum efficiency from their apparatus — truly an engineer-like object — and to enable his company to cheapen the apparatus by working toward mass production by the increase of sales. For the man who feels inclined toward the commercial and executive aspects of engineering we offer the sales field as a likely and likeable possibility.

UTILIZATION OF OIL SHALE

(Continued from page 157)

its relation to the fact that these gentlemen were apparently interested in proving there was no danger of petroleum shortage in the next twenty-five years. While the consumption of some forms of petroleum products may be larger and less efficient than they should be, the fact remains that so long as prices are as they are these practices are likely to continue and with oil resources as they apparently are and oil consumption as it certainly is and promises to continue to be, the supply of liquid fuels must be materially augmented from some source or sources within the next eight years.

The most probable source of this extra supply is the destructive distillation of low grade solid fuels such as lignite and oil shale. On account of the fact that the demand for the products of wood distillation is such

as to leave only a relatively small amount available as fuel and the fact that these more valuable products are produced from a material which is now recognized as an asset to be handled with care and not wasted over a few years, there is little likelihood of liquid fuels being produced to any appreciable extent from wood. Anthracite and semi-anthracite coal yield so little liquid material and are so valuable as solid fuel for particular purposes in which solid fuels are most desirable that it is unlikely that any appreciable amounts of these materials will be carbonized to yield liquid fuels. Bituminous coals have yielded and will continue to yield a large amount of material suitable for motor fuel and also other liquid fuels, but these materials are all very valuable in the manufacture of chemical products such as dyes and explosives and as such cannot be expected to be supplied as liquid fuels very cheaply.

Lignites and particularly oil shales yield light oils more closely analogous to the light oils produced from petroleum and as such may be expected to be carbonized extensively in the near future for these liquid fuel products. In spite of the fact that nobody knows how much oil shale or lignite there is, we do know that there are enormous quantities of both and that both are scattered all over the world. The Committee of Eleven in their previously mentioned report estimates the oil recoverable in the United States from lignites at seventy billion and from oil shale at 108 billion barrels. Of course we know neither how much there is nor how efficiently it can be recovered but that estimate is probably as good as any other at the present time and indicates that either or both are resources of liquid as well as solid fuels of large magnitude and potential importance.

Natural gas of an inflammable nature arising from swamps and pools and from crevices in the earth has been known for ages. Marco Polo in his record of his travels mentions an ancient fire temple of the Hindoos burning natural gas, and other instances have been recorded at many other places and times. Gas has been burning in the Baku peninsula in southern Russia for hundreds of years and has there given rise to a sect of fire worshippers. Natural gas was given no serious consideration as to commercial use until the discovery of gas in Kansas in the last century. The utilization of gas as a domestic fuel had been developed thru the various forms of artificial gas previous to this discovery; so the natural gas was recognized as valuable and was piped to towns and cities for heating and lighting. In spite of this, much of the gas was deliberately wasted in an effort to bring up oil and this waste continued in the oil fields for many years. Later much of the otherwise waste gas was burned incompletely to yield carbon black, a useful by-product, which was much better than letting it go to waste, tho not a particularly efficient use for this valuable fuel. Natural gas is a particularly desirable fuel on account of its high heating value, but piping costs and the fact that in relatively few instances has it been found near large centers of population has promoted waste of it. Very few large cities or industrial centers are so located as to be able to depend on this fuel and this fact is becoming increasingly true as the supply is being depleted.

Gas from coal was discovered in 1691 by Dr. John Clayton of Kildare, England, but was not put to any productive use until 1792,, when Murdock commenced his experiments which led to the lighting of his own residence by gas in 1797 and the illumination of the works of Boulton and Watt at Soho in 1802. The first street lighting was in a portion of the Pall Mall in Paris in 1809 and the development of gas for heating and lighting was continuous and rapid from then on until the incandescent electric light eclipsed the gas light and left gas to the heating field, in which it is particularly convenient and economical. The growth of large cities has been responsible for the utilization of gas and since the cities will certainly continue to exist and presumably continue to grow, the demand for gas for domestic fuel is almost as certain as anything can be, solid fuels being undesirable not only on account of the labor and dirt associated with them but also on account of the valuable space required for their storage. Gas has been used as automobile fuel but is not particularly desirable for that purpose. It is a very valuable industrial fuel and finds use in industries requiring cleanliness and efficient temperature control. In the little over a hundred years in which gas making has been developed, many different schemes have been used, going all the way from carbonization in which gas was a waste material to complete gasification systems in which neither coke, oil, nor tar is recovered, but only gas and ash. Of the intermediate systems the high and low temperature carbonization to yield solid, liquid and gaseous materials in varying quantities and qualities are the most popular.

Having considered how liquid and gaseous hydrocarbon fuels have developed from useless curiosities or absolute nuisances into our most desirable fuels, and having considered how man has progressed in the utilization of solid fuels and the fact that he is now requiring so much fuel that lower grade must be utilized; the problem confronting us is the selection of these materials and of the best methods of utilization of them. Several items are of importance: solid fuel of a smokeless kind must be produced from the raw smoky fuels; gaseous fuels and liquid fuels of various kinds must be produced; and waste in the process of conversion must be minimized by the application of efficient methods and by the recovery of valuable by-products where possible.

The low grade fuels available are the sub-bituminous coals, brown coals, lignites, peats and oil shales. Not enough is yet known about these materials to make very clear comparisons possible, but we do know that all of them are amenable to low temperature carbonization, yielding varying amounts of gas and of liquid materials of different kinds. All the first four have

the advantage over shale of leaving a solid residue or coke sufficiently low in ash to make possible its use as fuel. Apparently, however, the oil shale has material advantages in the nature of the liquid products formed, as these seem to give much better motor fuels and lubricants than the other materials.

The original systems of treating solid fuels were the crude and wasteful systems of conversion of one solid fuel to a more desirable form like the heap charcoal burner and the beehive coke ovens. These systems lost all the liquid and gaseous products. Next came systems of distillation with recovery of tars and pitches and finally there were developed the systems for the recovery of light liquids and gases. The various forms of low temperature carbonization are becoming more popular because they yield a maximum of liquid products desirable not only for fuel but for lubricants and for the preparation of organic chemical derivatives. Their application to the coke forming material may be subject to many modifications in the effort to make solid fuels of certain desired characteristics but their application to oil shale should be simpler because the problem there is the recovery of the liquid products in the most desirable form and largest possible quantity and the residue seems to have only two possibilities, namely, steaming to produce water gas and ammonia and incomplete combustion to give producer gas.

Oil shales have been used directly as solid fuels in various places and at various times, their use by the Mormons in Utah having been previously citied. Another and more recent use is in Esthonia where the deposits are very rich and extensive and the ash is such that the shale is said to have been used to fire locomotives. A large scale commercial utilization of oil shales has been limited to Scotland, where the present industry was started by James Young in 1848, working on torbanite, a rich material of 96 to 130 gallons, however, instead of on the present lean shales. The rich material was exhausted in 1862 and 45 gallon shale was then used, going successively to leaner material until at present fifteen gallon shale is being retorted successfully. This oil shale is high in nitrogenous matter and the profits from ammonium sulphate produced together with the government subsidy make possible the production of oil from such lean material. The procedure employed is low temperature carbonization for oil yield followed by steaming to give water gas and ammonia. Various systems have been tried on the widely differing oil shale deposits over the world with varying success. The only one in the United States which has approximated commercial operation is the Catlin plant at Elko, Nevada, where the retorting process is again low temperature carbonization but this time followed by utilization of the spent shale in a gas producer.

In view of the foregoing data on the fuel basis alone and neglecting the other important aspects such as lubricants, ammonium sulphate and chemical derivatives, it would seem safe to conclude that oil shales must be used in the near future; that some materials which fall under this classification may be used directly as solid fuels and some others may be subjected to complete gasification; but that most of the oil shale will be treated by some form of low temperature carbonization to get the maximum yield of the most desirable liquid products; that the spent shale will be treated to give water gas or producer gas, and that this gas and the gas from the retort proper will be used for fuel at the retort, for domestic fuel, for making carbon black or in whatever way is best suited to the location and nature of the retorting plant. We may conclude also that in view of the apparent impending shortage of petroleum, such development of the oil shale industry to a commercial scale in the United States will take place within the next eight years. It will take money for investigation and money for plant construction, but not a prohibitive amount when we compare it with the fifty million dollars annual expenditure on dry holes by the petroleum industry.

THE CONCRETE ARCH-BRIDGE

(Continued from page 153)

Eight special electric winches, with increased gear ratios and eighteen inch diameter drums which will hold 500 feet of 7-8 inch cable, are used to swing up the four quarters of each set of arch centers simultaneously. Four of them are placed on each of the two piers on which the arch centers are to be placed—two raising each quarter. They each have a single line capacity of eleven tons and work through eight-part block and falls with 18-inch outside flange diameter sheaves, which are fastened to the tops of the bents. A 2½-inch cable extends from the lower block to a large diameter equalizer sheave, fastened to the end of the quarter section away from the pier, and then back to the other set of block and falls. In this way the two winches swinging up each quarter carry equal loads. As they each have a single line capacity of eleven tons and work through eight-part block and fall systems, their combined capacity is 176 tons. Each quarter of the steel arch spans weighs 100 tons, so there is a large factor of safety.

The sixty foot wooden bents on the pier skewbacks are prevented from being pulled forward by means of 2½-inch back-stay cables running back from the upper four blocks, to the next pier behind. Only two long cables are used instead of four. Each of them runs through a large diameter equalizer sheave securely bound with cables, fastened with clips, to the pier used for anchoring. The two ends of each are fastened to the two upper blocks on each side of the bent above.

With the steel arch centering in place, wooden forms are placed on it and the concrete poured. When the concrete has set, the arch centers are lowered by reversing the operation just described, skidded out—a quarter at a time—on to special trucks on the temporary trestle track by means of two sets of five line block and tackle at the ends of each quarter, operated by the

hoisting and closing lines from the boom end of one of the American Locomotive Cranes. The quarters are then pulled along the trestle, one at a time, to their new location. They are then skidded into their horizontal position in readiness for being raised into another steel arch center by reversing the operation of skidding them out on to the trestle from their previous location. There are three sets of these steel arch centers.

The Mendota bridge will be 4,119 feet long—one of the longest, if not the longest, concrete arch bridges in the world. It will be the only bridge of similar construction with twelve spans of equal size. The bridge will weigh 148,000 tons, contain 75,000 cubic yards of concrete, and will have about 300,000 square feet of concrete surface. It is estimated that approximately a million feet of lumber will be required for the falsework. A million feet of timber did go into the temporary working trestle which runs parallel with the line of the bridge for its entire length. Most of the piles that went into this trestle are seventy feet long and have a penetration of forty feet.

—*Courtesy of American Hoist & Derrick Co.*

RAISING THE SOUTHERN CROSS

(Continued from page 151)

Salvador. The trail was rough; and it was a long hard ride. But that week-end was our diversion, hard as it was.

"The Florida boom came in on the air."

When the work on the railroad was well under way, and all things connected with the job were running smoothly, the news of the Florida boom came in on the air.

At an unfortunate moment for the Soyapango, someone tuned in on Miami. Filling for the moment the role of El Dorado, the Siren, Madame Florida demanded our presence. And so the Salvador local of the Lost Legion went "down to the sea in a ship", leaving the Soyapango in the hands of a troubled chief engineer, and a crew of more troubled youngsters from the States.

But we'll all go back to our own again. We've nibbled at the lotus too often. We've listened to "the wind in the palm trees", the tolling chimes of

the cathedral bells in Santa Tuna Plaza, and the heavy boom of the long Carribean rollers smashing over the break-water of Limon Bay. And over Balboa Brew on Bolivar Street, we'll take up our old occupation of knocking the tropics, and continue our wail for far away "little old New York."

CONCRETE COLUMNS

(Continued from page 158)

3. Butt-end splices can be expected to develop 100-percent efficiency if the contact ends of the rods are sawed off square and are held in place by snug fitting pipes. Precautions must be observed to prevent displacement of the pipe sleeves while the concrete is poured.

4. When butt-joints are made with rods sheared at the ends, and when the pipe sleeves fit loosely, the splice may develop 100% efficiency. However, it would be better to allow for only 95% efficiency.

5. In setting the reinforcement, less difficulty is encountered when snug pipe sleeves are used.

6. It is evident that butt-joints as used in this investigation should not be used in columns subjected to eccentric loading, where tension might exist in some of the rods.

7. Lap joints, whether tied or loose, are not satisfactory if the rods are lapped only two inches. The bonding strength developed is not sufficient to transmit the full column load.

8. Lap joints in which the rods are lapped 20 diameters can be expected to develop an efficiency of 90% of the full column strength.

9. When the rods are lapped 40 diameters the splice can be expected to develop full strength. In fact, the reinforcing effect of the double rods is such that the splice portion is noticably stiffened. This is due to the bond developed with the concrete.

10. Lap splices should be equally effective for columns under eccentric load, or for other members in which tensile stresses may exist.

11. The strength of a reinforced concrete column is less under static load continuously applied than under rapidly increasing test load. The efficiency of a splice is probably not affected by the rate of loading.

Appendix

Mr. Turkovich's thesis gives a list of bulletins and reports on plain and reinforced concrete column tests. The nature and scope of each investigation is briefly stated.

The appendix also contains extracts from the building codes of principal American cities.

Acknowledgments

This research problem was suggested by Dean F. E. Turneaure. It was outlined and closely supervised by Prof. M. O. Withey. The writer supervised the making of the specimens. Messrs E. C. Dye and L. A. Metz, graduate students in civil engineering, assisted Mr. Turkovich in the tests and computations. The spiral reinforcement was donated by the Corrugated Bar Company, Inc. of Buffalo, N. Y.

SHOP LIGHTING

In an address delivered before the members of the Western Pennsylvania division of the National Safety Council, Pittsburg, Pa., March, 1918, by C. W. Price, the importance of good lighting in industrial establishments was discussed, and the disadvantages of poor lighting were clearly shown by some figures mentioned by Mr. Price.

A large insurance company analyzed 91,000 accident reports, for the purpose of discovering the causes of these mishaps. It was found that 10% was directly traceable to inadequate lighting and in 13.8% the same cause was a contributory factor. The British Government in a report of the investigation of causes of accidents determined a close parallel to the findings of the insurance company above quoted. The British investigators found that by comparing the four winter months with the four summer months, there were 39.5% more men injured by stumbling and falling in winter than in summer.

Mr. John Calder, a pioneer in safety work, made an investigation of accident statistics covering 80,000 industrial plants. His analysis covered 700 accidental deaths, and of these 45% more occurred during the four winter months than during the four summer months.

Mr. C. L. Eschleman, in a paper published in the proceedings of the American Institute of Electrical Engineers several years ago, reported the result of an investigation of a large number of plants in which efficient lighting had been installed. He found that in such plants as steel mills, where the work is of a coarse nature, efficient lighting increased the total output 2%; in plants, such as textile mills and shoe factories, the output was increased 10%.

In an investigation of the causes of eye fatigue, made by the Industrial Commission of Wisconsin, it was found that in a large percentage of industries, such as shoe, clothing and textile factories, the lack of proper lighting (both natural and artificial) resulted in eye fatigue and loss of efficiency. At one knitting mill, where a girl was doing close work under improper lighting conditions, her efficiency dropped 50% every day during the hours from 2:30 to 5:30 P. M.

The above mentioned incidents indicate how important a factor lighting is in the operation of the industrial plant. It has been well said, "Light is a tool, which increases the efficiency of every tool in the plant." Glare or too much light is as harmful as not enough lighting, and in no case should the eyes of the workers be exposed to direct rays, either of sun or electric light.

Windows and reflectors should always be kept clean; that is, cleaning them at least once a week, for where dust and dirt are allowed to collect, efficiency of the light is decreased as much as 25%.

Good lighting, in addition to its other marked advantages, is a strong incentive towards keeping working places clean, for it clearly exposes any place where dirt or other material has been allowed to collect. White walls and clean windows glazed with Factrolite Glass will eliminate the sun glare and increase the illumination 25 to 50 feet from the window from 38% to 72% as compared with plain glass.

Lighting is of primary importance to every employer and fully warrants a careful investigation of the subject, for there is no substitute for good lighting, and if it is not supplied the efficiency of the entire working force must suffer a serious reduction.

If you are interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

MISSISSIPPI WIRE GLASS CO.,

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No. 5.

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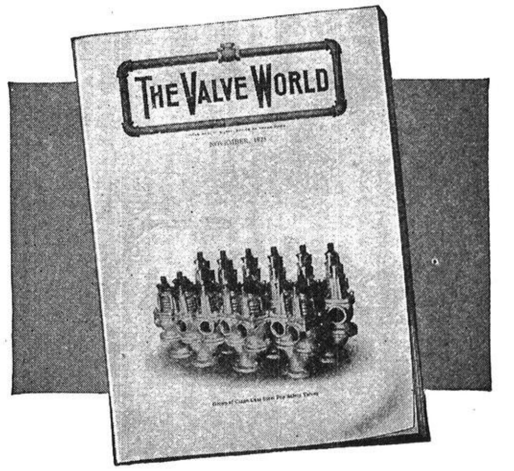

The Valve World—free

Earnest engineering students will find much to interest them in *The Valve World*, the monthly magazine of Crane Co. A recent issue, for example, contained articles on "Accuracy in high-temperature testing of materials," "Waste in industry," and "Engine failures due to improper piping," in addition to a large variety of other subjects, well illustrated with photographs and diagrams. Besides, in each issue Old Fogy distills the milk of human kindness in his mellow philosophical talks on current questions. To interested students, we will gladly send a sample copy on request. If you like it, a note from you will enter your name on the free subscription list, to receive it regularly.

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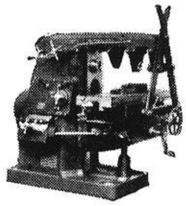
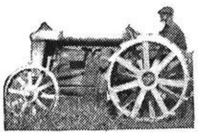
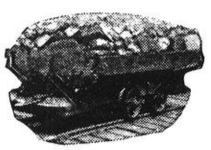
Manufacture 

 Farming

Transportation 

 Mining

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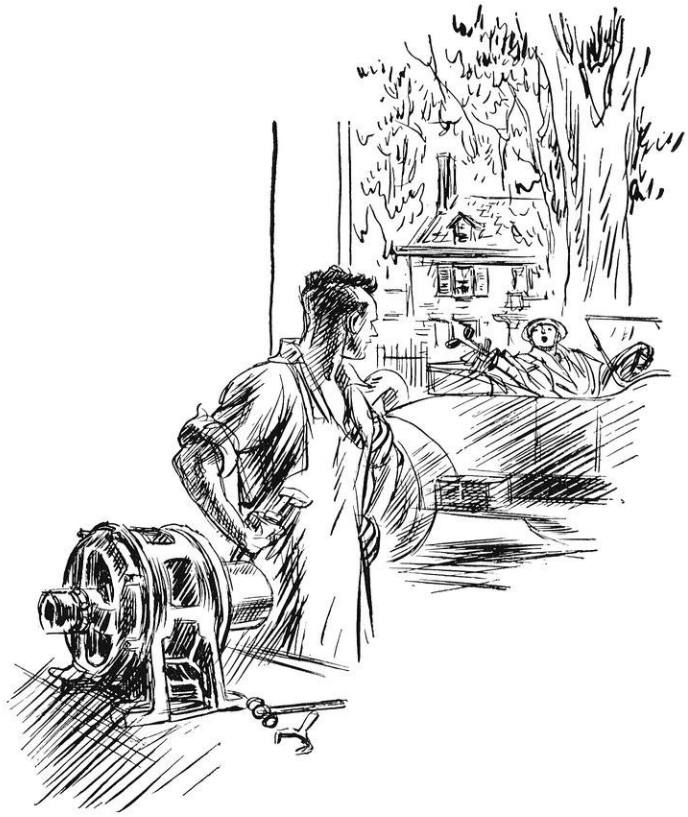

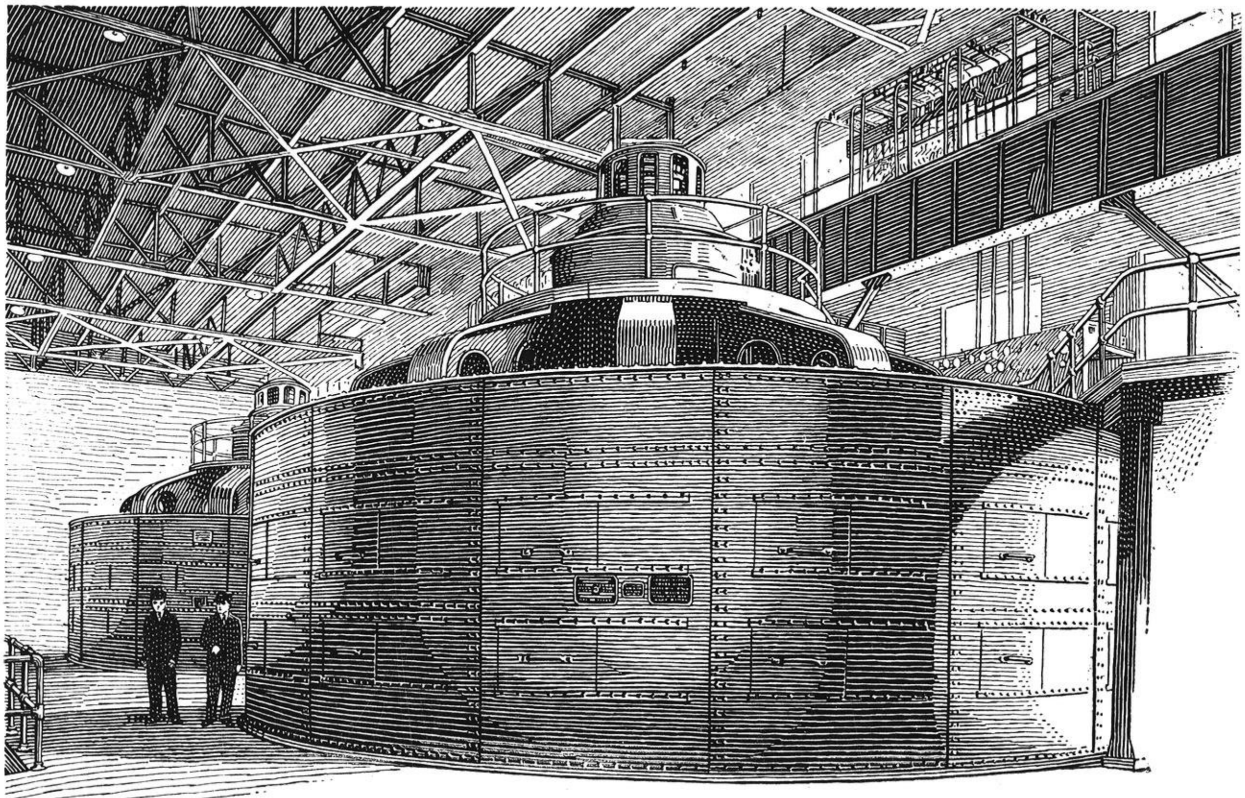

This giant hydro-electric unit weighs 750 tons and consists of a vertical shaft hydraulic turbine attached to an electric generator delivering 52,000 kilowatts at 12,000 volts.